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Central Artery—Boston, Massachusetts

PART II

- Alternatives Analyses

PART III

- Section 4(f) Evaluation

Federal Highway Administration
Massachusetts Department of Public Works

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CENTRAL ARTERY (I-93)/
THIRD HARBOR TUNNEL (I-90) PROJECT

DRAFT

SUPPLEMENTAL

ENVIRONMENTAL IMPACT STATEMENT/REPORT AND SUPPLEMENTAL FINAL SECTION 4(f) EVALUATION

PART II

- **Project Changes And Refinements Since 1985 FEIS/R**

PART III

- **Section 4(f) Evaluation**

Federal Highway Administration
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Table of Contents

Table Of Contents

Page

PART I

1 SUMMARY 1

1 INTRODUCTION 1-1

1.1 PURPOSE OF SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT/REPORT 1-1

1.2 PURPOSE AND NEED FOR ACTION 1-4

1.3 HISTORY OF PROJECT DEVELOPMENT 1-5

1.4 MAJOR POLICY ISSUES AFFECTING PROJECT DEVELOPMENT SINCE 1985 1-6

1.5 REGULATORY FRAMEWORK AND COMPLIANCE 1-10

1.6 ORGANIZATION OF THE SEIS/R 1-11

2 PROPOSED ACTION 2-1

2.1 OVERVIEW 2-1

2.2 PROJECT DESCRIPTION BY SUBAREA 2-2
2.2.1 Area North Of Causeway Street 2-3
2.2.2 Central Area 2-4
2.2.3 I-93/I-90 Interchange And Massachusetts Avenue Interchange Area 2-5
2.2.4 South Boston/South Boston Bypass Road Area 2-7
2.2.5 Third Harbor Tunnel Area 2-8
2.2.6 East Boston/Logan Airport Area 2-9

2.3 COMPARISON OF THE PROPOSED ACTION TO THE FEIS/R PREFERRED ALTERNATIVE 2-10
2.3.1 Area North Of Causeway Street 2-10
2.3.2 Central Area 2-11
2.3.3 I-93/I-90 Interchange And Massachusetts Avenue Interchange Area 2-11
2.3.4 South Boston/South Boston Bypass Road Area 2-12
2.3.5 Third Harbor Tunnel Area 2-12
2.3.6 East Boston/Logan Airport Area 2-12
2.3.7 High-Occupancy Vehicle (HOV) System 2-13
2.3.8 Tunnel Ventilation 2-15

Table Of Contents - Part I (Cont.)

Page

2.4 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 2-15

3 **TRANSPORTATION** 3-1

3.1 AFFECTED ENVIRONMENT 3-1
- 3.1.1 Highway And Street Network 3-2
- 3.1.2 Traffic Volumes 3-4
- 3.1.3 Traffic Operations 3-4
- 3.1.4 Truck Movements And Inflammable Cargo Routes 3-16
- 3.1.5 Parking Facilities 3-19
- 3.1.6 Safety 3-19
- 3.1.7 Public Transit 3-20
- 3.1.8 Air Transportation 3-21
- 3.1.9 Pedestrian Circulation 3-21
- 3.1.10 Bicycling 3-22

3.2 ENVIRONMENTAL CONSEQUENCES 3-23
- 3.2.1 Summary Of Project Transportation Impacts 3-23
- 3.2.2 Transportation Analysis Methodology 3-24
- 3.2.3 Projected Traffic Volumes 3-27
- 3.2.4 Projected Traffic Operations 3-52
- 3.2.5 Other Projected Vehicular Traffic Characteristics 3-71
- 3.2.6 Project Impacts On Other Transportation Facilities 3-90

3.3 MITIGATION MEASURES 3-98
- 3.3.1 Traffic Surveillance And Control System (TSCS) 3-99
- 3.3.2 Public Transportation 3-99
- 3.3.3 Parking Supply Management 3-105
- 3.3.4 Street Direction Changes 3-105

3.4 COMPARISON WITH FEIS/R 3-105

3.5 RESOLUTION OF ISSUES RAISED BY AGENCIES 3-107

4 **AIR QUALITY** 4-1

4.1 AIR POLLUTANTS 4-1

4.2 AIR QUALITY STANDARDS AND REGULATIONS 4-2
- 4.2.1 National And State Ambient Air Quality Standards 4-2
- 4.2.2 Massachusetts NO_2 Policy Level 4-2
- 4.2.3 Toxic Pollutants In Vehicular Exhaust 4-4

4.3 POLLUTANTS FOR ANALYSIS 4-6

Table Of Contents - Part I (Cont.)

Page

4.4 AFFECTED ENVIRONMENT: EXISTING AIR QUALITY 4-7
  4.4.1 Monitored Levels 4-7
  4.4.2 Existing (1987) Carbon Monoxide Levels In The Project Area Estimated Based On Microscale Modeling 4-10
  4.4.3 Estimated Areawide Pollutant Emissions In 1987 (Mesoscale Analysis) 4-14

4.5 ENVIRONMENTAL CONSEQUENCES: CARBON MONOXIDE LEVELS IN 1998 WITH AND WITHOUT THE PROPOSED ACTION 4-23
  4.5.1 Estimated CO Levels In 1998 Based On Microscale Modeling 4-23
  4.5.2 Estimated Areawide Pollutant Emissions In 1998 With And Without The Proposed Action 4-28

4.6 ENVIRONMENTAL CONSEQUENCES: CARBON MONOXIDE LEVELS IN 2010 WITH AND WITHOUT THE PROPOSED ACTION 4-32
  4.6.1 Estimated CO Levels In 2010 Based On Microscale Modeling 4-32
  4.6.2 Estimated Areawide Pollutant Emissions In 2010 With And Without The Proposed Action 4-37

4.7 CARBON MONOXIDE LEVELS IN THE VICINITY OF TOLL PLAZAS 4-41

4.8 CARBON MONOXIDE CONCENTRATIONS IN PROPOSED TUNNELS 4-41
  4.8.1 Ventiliation Criteria 4-41
  4.8.2 Tunnel Design 4-42

4.9 TUNNEL VENTILATION SYSTEM 4-42
  4.9.1 Introduction 4-42
  4.9.2 Ventilation Requirements And Design Constraints 4-43
  4.9.3 Candidate Site Screening And Selection Process 4-44
  4.9.4 Comparative Evaluation Of Potential Ventilation Building Sites 4-45
  4.9.5 Ventilation System Design Concepts 4-46
  4.9.6 Proposed Ventilation System Design 4-46

4.10 AIR QUALITY IMPACTS OF VENTILATION BUILDINGS 4-46
  4.10.1 Emissions From Ventilation Buildings 4-48
  4.10.2 Air Quality Modeling Procedures 4-48
  4.10.3 Background Concentrations 4-56
  4.10.4 Results Of Analysis Of Automotive Exhaust Passing Through Ventilation Buildings 4-56
  4.10.5 Ventilation Building Design Considerations 4-59
  4.10.6 Combined Impacts From All Ventilation Buildings 4-59
  4.10.7 Combined Mobile Source And Ventilation Building Impacts 4-69

4.11 MITIGATION MEASURES 4-70

Table Of Contents - Part I (Cont.)

Page

4.12 COMPARISON WITH 1985 FEIS/R 4-70

4.13 CONFORMANCE WITH THE STATE IMPLEMENTATION PLAN 4-71

4.14 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 4-71

5 NOISE AND VIBRATION 5-1

5.1 AFFECTED ENVIRONMENT: NOISE 5-1
5.1.1 Ambient Noise Levels 5-1

5.2 ENVIRONMENTAL CONSEQUENCES: NOISE 5-2
5.2.1 Traffic Noise Impacts 5-2
5.2.2 Ventilation Noise Levels 5-23
5.2.3 Noise At Tunnel Portals 5-25

5.3 MITIGATION MEASURES: NOISE 5-25
5.3.1 Noise Barrier Analyses 5-26

5.4 COMPARISON WITH FEIS/R: NOISE 5-29

5.5 AFFECTED ENVIRONMENT: VIBRATION 5-30
5.5.1 Existing Vibration Levels 5-30

5.6 ENVIRONMENTAL CONSEQUENCES: VIBRATION 5-35
5.6.1 Vibration Impacts 5-35

5.7 MITIGATION MEASURES: VIBRATION 5-35

5.8 COMPARISON WITH FEIS/R: VIBRATION 5-36

5.9 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 5-36

6 ENERGY 6-1

6.1 AFFECTED ENVIRONMENT 6-1

6.2 ENVIRONMENTAL CONSEQUENCES 6-1
6.2.1 Direct Energy Analysis 6-1
6.2.2 Indirect Energy Analysis 6-3

6.3 MITIGATION MEASURES 6-3

6.4 COMPARISON WITH FEIS/R 6-3

6.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 6-5

Table Of Contents - Part I (Cont.)

Page

7 ECONOMIC CHARACTERISTICS 7-1

7.1 AFFECTED ENVIRONMENT 7-1
7.1.1 Changes In Regional Economy Since FEIS/R 7-1
7.1.2 Changes In Economic Activity Since FEIS/R By Subarea 7-20

7.2 ENVIRONMENTAL CONSEQUENCES 7-25
7.2.1 Metropolitan Economic Forecasts 7-26
7.2.2 Office Impacts 7-34
7.2.3 Retail Business Impacts 7-37
7.2.4 Industrial, Wholesale, And Maritime Business Impacts 7-40
7.2.5 Residential Impacts 7-43
7.2.6 Tourism Impacts 7-44
7.2.7 Impact On Institutions 7-50
7.2.8 Overall Impacts On The Economy 7-51
7.2.9 Transportation System Efficiency Benefits 7-51
7.2.10 Fiscal Impacts 7-54

7.3 MITIGATION MEASURES 7-56

7.4 COMPARISON WITH FEIS/R 7-57

7.5 RESOLUTION OF ISSUES RAISED BY AGENCIES 7-57

8 LAND USE AND NEIGHBORHOOD CHARACTERISTICS 8-1

8.1 AFFECTED ENVIRONMENT 8-1
8.1.1 Area North Of Causeway Street 8-2
8.1.2 Central Area 8-4
8.1.3 I-93/I-90 Interchange And Massachusetts Avenue Interchange Area 8-8
8.1.4 South Boston And South Boston Bypass Road Area 8-10
8.1.5 East Boston/Logan Airport Area 8-12

8.2 ENVIRONMENTAL CONSEQUENCES/LAND USE IMPACTS 8-14
8.2.1 Land Use Impact Overvew 8-14
8.2.2 Neighborhood Impact Overview 8-15
8.2.3 Joint Development Overview 8-15
8.2.4 Relocation 8-15
8.2.5 Consistency Of Proposed Action With Local Plans 8-16
8.2.6 Regional Land Use Impacts 8-16
8.2.7 Specific Project-Related Land Use Changes 8-16
8.2.8 Land Use Impacts By Subarea 8-17

8.3 MITIGATION MEASURES 8-39

Table Of Contents - Part I (Cont.)

Page

8.4 COMPARISON WITH FEIS/R 8-40
8.4.1 Area North Of Causeway Street 8-40
8.4.2 Central Area 8-41
8.4.3 I-93/I-90 Interchange And Massachusetts Avenue Interchange Area 8-41
8.4.4 South Boston And South Boston Bypass Road Area 8-42
8.4.5 East Boston/Logan Airport Area 8-42

8.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 8-42

9 VISUAL CHARACTERISTICS 9-1

9.1 AFFECTED ENVIRONMENT 9-1
9.1.1 Area North Of Causeway Street 9-1
9.1.2 Central Area 9-2
9.1.3 I-93/I-90 Interchange And Massachusetts Avenue Interchange Area 9-4
9.1.4 South Boston And South Boston Bypass Road Area 9-4
9.1.5 East Boston/Logan Airport Area 9-5

9.2 ENVIRONMENTAL CONSEQUENCES 9-6
9.2.1 The Charles River Bridges 9-7
9.2.2 Gateways 9-8
9.2.3 Tunnels 9-11
9.2.4 Central Artery Corridor 9-12
9.2.5 Ventilation Buildings 9-15

9.3 MITIGATION MEASURES 9-17
9.3.1 Charles River Bridges 9-18
9.3.2 Gateways 9-18
9.3.3 Tunnels 9-19
9.3.4 Central Artery Corridor 9-19
9.3.5 Ventilation Buildings 9-19
9.3.6 Projectwide 9-19

9.4 COMPARISON WITH FEIS/R 9-20
9.4.1 Charles River Bridges 9-20
9.4.2 Gateways 9-20
9.4.3 Tunnels 9-20
9.4.4 Central Artery Corridor 9-20
9.4.5 Ventilation Buildings 9-21

9.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 9-21

Table Of Contents - Part I (Cont.)

Page

10 HISTORIC RESOURCES 10-1

10.1 AFFECTED ENVIRONMENT 10-1

10.2 ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES 10-4

10.3 COMPARISON WITH FEIS/R 10-17

10.4 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 10-19

11 ARCHAEOLOGICAL RESOURCES 11-1

11.1 AFFECTED ENVIRONMENT 11-1

11.2 ENVIRONMENTAL CONSEQUENCES 11-4

11.3 MITIGATION MEASURES 11-4

11.4 COMPARISON WITH FEIS/R 11-5

11.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 11-5

12 UTILITIES 12-1

12.1 AFFECTED ENVIRONMENT 12-1

12.2 ENVIRONMENTAL CONSEQUENCES 12-1

12.3 MITIGATION MEASURES 12-4

12.4 COMPARISON WITH FEIS/R 12-4

12.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 12-5

13 WATER QUALITY 13-1

13.1 AFFECTED ENVIRONMENT 13-1
13.1.1 Fort Point Channel 13-1
13.1.2 Boston Inner Harbor 13-8
13.1.3 Lower Charles River And Millers River 13-16
13.1.4 Industrial Water Use 13-23
13.1.5 Groundwater 13-23

13.2 ENVIRONMENTAL CONSEQUENCES 13-26
13.2.1 Fort Point Channel 13-26
13.2.2 Boston Inner Harbor 13-30

Table Of Contents - Part I (Cont.)

Page

13.2.3 Lower Charles River And Millers River 13-31
13.2.4 Projectwide Issues 13-33

13.3 MITIGATION MEASURES 13-39

13.4 COMPARISON WITH FEIS/R 13-40

13.5 SUMMARY OF MAJOR FINDINGS 13-41

13.6 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 13-42

14 WETLANDS AND WATERWAYS 14-1

14.1 AFFECTED ENVIRONMENT 14-3
14.1.1 Lower Charles River And Millers River 14-3
14.1.2 Fort Point Channel 14-12
14.1.3 Boston Inner Harbor 14-16

14.2 ENVIRONMENTAL CONSEQUENCES 14-29
14.2.1 Lower Charles River and Millers River 14-30
14.2.2 Fort Point Channel 14-39
14.2.3 Boston Inner Harbor 14-43

14.3 MITIGATION 14-49

14.4 COMPARISON WITH FEIS/R 14-51

14.5 RESOLUTION OF MAJOR ISSUES RAISED BY PUBLIC AGENCIES 14-52

15 FLOODPLAINS 15-1

15.1 AFFECTED ENVIRONMENT 15-1

15.2 ENVIRONMENTAL CONSEQUENCES 15-1

15.3 MITIGATION MEASURES 15-2

15.4 COMPARISON WITH FEIS/R 15-3

15.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 15-3

16 VEGETATION AND WILDLIFE 16-1

16.1 AFFECTED ENVIRONMENT 16-1

16.2 ENVIRONMENTAL CONSEQUENCES 16-1

Table Of Contents - Part I (Cont.)

Page

16.3 MITIGATION MEASURES 16-2

16.4 COMPARISON WITH FEIS/R 16-2

16.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 16-2

17 SOILS AND GEOLOGY 17-1

17.1 AFFECTED ENVIRONMENT 17-1

17.2 ENVIRONMENTAL CONSEQUENCES 17-2

17.3 MITIGATION MEASURES 17-2

17.4 COMPARISON WITH FEIS/R 17-2

17.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 17-2

18 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES 18-1

18.1 INTRODUCTION 18-1

18.2 COMMITMENT OF RESOURCES 18-1

18.3 RELATIONSHIP TO OTHER PROJECTS 18-2

18.4 RESOLUTION OF ISSUES RAISED BY AGENCIES 18-6

19 SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY 19-1

19.1 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY 19-1

19.2 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 19-3

20 SUMMARY OF CONSTRUCTION ACTIVITY 20-1

20.1 PROPOSED CONSTRUCTION PLAN 20-1
  20.1.1 Construction Activities 20-2
  20.1.2 Construction Schedule And Sequencing 20-10
  20.1.3 Construction Managment 20-13

20.2 IMPACTS DURING CONSTRUCTION 20-16
  20.2.1 Traffic And Transportation 20-16

Page

20.2.2 Economic Activity During Construction 20-36
20.2.3 Utilities 20-49
20.2.4 Air Quality 20-53
20.2.5 Noise And Vibration 20-59
20.2.6 Water Resources, Ecology And Wetlands 20-69
20.2.7 Aesthetic And Visual Considerations 20-83
20.2.8 Historic Resources And Archaeology 20-88
20.2.9 Nuisance Abatement 20-89

20.3 MITIGATION MEASURES 20-93
20.3.1 Mitigation Planning 20-94
20.3.2 Maintenance Of Traffic Plan 20-95
20.3.3 Mitigation Program Summary 20-96

20.4 COMPARISON WITH FEIS/R 20-99
20.4.1 Construction Methods 20-99
20.4.2 Traffic And Transportation 20-100
20.4.3 Economic Effects 20-100
20.4.4 Utilities 20-101
20.4.5 Air Quality 20-102
20.4.6 Noise And Vibration 20-102
20.4.7 Water Resources And Ecology 20-103
20.4.8 Aesthetic And Visual Impacts During Construction 20-104
20.4.9 Historic Resources And Archaeology 20-104
20.4.10 Nuisance Abatement 20-104

20.5 RESOLUTION OF ISSUES RAISED BY PUBLIC AGENCIES 20-104
20.5.1 Analysis Of Air Quality, Traffic, And Noise Impacts 20-104
20.5.2 Delayed Completion Of Seaport Access Road And Opening Of Third Harbor Tunnel 20-105
20.5.3 Maintenance Of Traffic 20-105
20.5.4 Conveyor System 20-105
20.5.5 Public Agency Participation 20-106

AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THE SEIS/R WERE SENT

LIST OF PREPARERS

GLOSSARY

ABBREVIATIONS

INDEX

Table Of Contents - Part II

Page

PART II

A INTRODUCTION IIA-1

B ANALYSIS OF ALTERNATIVE DESIGN OPTIONS

1 AREA NORTH OF CAUSEWAY STREET IIB 1-1

1.1 INTRODUCTION IIB 1-1
  1.1.1 Background IIB 1-1
  1.1.2 Design Objectives IIB 1-3
  1.1.3 Evolution Of Roadway Options IIB 1-7

1.2 DESCRIPTION OF OPTIONS IIB 1-8
  1.2.1 Option 5A Modified IIB 1-8
  1.2.2 Option S Modified IIB 1-10
  1.2.3 Option T Modified IIB 1-12
  1.2.4 Option Z Modified IIB 1-14

1.3 TRAFFIC OPERATIONS IIB 1-15
  1.3.1 Method Of Analysis IIB 1-16
  1.3.2 Option 5A Modified IIB 1-18
  1.3.3 Option S Modified IIB 1-19
  1.3.4 Option T Modified IIB 1-20
  1.3.5 Z Modified IIB 1-21
  1.3.6 Comparison Of Traffic Operations And Impacts IIB 1-23
  1.3.7 Pedestrian/Bicycle Circulation IIB 1-24

1.4 LONG-TERM ENVIRONMENTAL IMPACTS IIB 1-37
  1.4.1 Air Quality IIB 1-37
  1.4.2 Noise IIB 1-41
  1.4.3 Wetlands, Aquatic Ecology, And Water Quality IIB 1-44
  1.4.4 Floodplains IIB 1-48
  1.4.5 Waterways/Navigation IIB 1-48
  1.4.6 Land Use Impacts IIB 1-50
  1.4.7 Open Space And Parkland IIB 1-52
  1.4.8 Visual Impacts IIB 1-57
  1.4.9 Relocation Impacts IIB 1-63
  1.4.10 Historic Resources IIB 1-65

1.5 CONSTRUCTION PERIOD IMPACTS IIB 1-67
  1.5.1 Traffic Impacts IIB 1-67
  1.5.2 Air Quality Impacts IIB 1-68
  1.5.3 Noise And Vibration IIB 1-68
  1.5.4 Wetlands, Aquatic Ecology, And Water Quality IIB 1-69

Table Of Contents - Part II (Cont.)

Page

1.5.5 Floodplains IIB 1-69
1.5.6 Waterways/Navigation IIB 1-70
1.5.7 Land Use IIB 1-71
1.5.8 Open Space And Parklands IIB 1-71
1.5.9 Visual Impacts IIB 1-72
1.5.10 Relocation IIB 1-72
1.5.11 Historic Resources IIB 1-72
1.5.12 Constructibility IIB 1-72
1.5.13 Construction Of Tunnels Under The Charles River IIB 1-75

1.6 RELATED DESIGN ISSUES IIB 1-79
1.6.1 Ventilation Building Locations IIB 1-79
1.6.2 Potential Bridge Design Modifications IIB 1-81

1.7 COMPARISON OF OPTIONS IIB 1-83
1.7.1 Summary Of Findings On Selected Key Issues IIB 1-95
1.7.2 Conclusion IIB 1-97

1.8 PROPOSED MITIGATION MEASURES IIB 1-97

2 SOUTH BOSTON BYPASS ROAD IIB 2-1

2.1 PURPOSE OF THE BYPASS ROAD IIB 2-1

2.2 BACKGROUND IIB 2-1
2.2.1 Haul Road IIB 2-2
2.2.2 Bypass Road Study Schemes IIB 2-2

2.3 ALTERNATIVES CONSIDERED IN THIS ANALYSIS IIB 2-3
2.3.1 Haul Road (The No-Action Alternative) IIB 2-3
2.3.2 Bypass Road (The Proposed Action) IIB 2-5

2.4 ASSESSMENT OF IMPACTS IIB 2-7
2.4.1 Traffic/Transportation IIB 2-7
2.4.2 Environmental Impacts IIB 2-12
2.4.3 Other Impacts IIB 2-20

2.5 SELECTION OF PROPOSED ACTION IIB 2-22
2.5.1 Summary Comparison Of Alternatives IIB 2-22
2.5.2 Selection Of Preferred Alternative IIB 2-23

3 TOLL PLAZA LOCATIONS IIB 3-1

3.1 DEVELOPMENT OF ALTERNATIVES IIB 3-1
3.1.1 Design Objectives IIB 3-1
3.1.2 Background IIB 3-2

Table Of Contents - Part II (Cont.)

Page

3.2 DESCRIPTION OF ALTERNATIVES IIB 3-3
3.2.1 Design Constraints IIB 3-3
3.2.2 South Boston Toll Plaza IIB 3-4
3.2.3 Logan Airport Toll Plazas IIB 3-5

3.3 ALTERNATIVES ANALYSIS IIB 3-5
3.3.1 Traffic And Transportation IIB 3-5
3.3.2 Environmental Issues IIB 3-9
3.3.3 Land Use And Community Facilities IIB 3-12

3.4 SELECTION OF PROPOSED ACTION IIB 3-14
3.4.1 Summary Comparison Of Toll Plaza Alternatives IIB 3-14
3.4.2 Selection Of Proposed Action IIB 3-15

4 MATERIALS DISPOSAL IIB 4-1

4.1 INTRODUCTION IIB 4-1
4.1.1 Purpose Of This Chapter IIB 4-1
4.1.2 Basis For Developing Disposal Options IIB 4-3
4.1.3 Organization Of This Chapter And Key Issues IIB 4-5

4.2 DISPOSAL METHODS, LOGISTICS, AND MATERIAL CHARACTERISTICS IIB 4-7
4.2.1 Artery/Tunnel Project Construction Areas IIB 4-7
4.2.2 Transportation Methods And Materials Movement Options IIB 4-8
4.2.3 Material Quantities IIB 4-15
4.2.4 Material Quality IIB 4-16

4.3 IDENTIFICATION OF POTENTIAL DISPOSAL SITES IIB 4-27
4.3.1 Artery/Tunnel Disposal Site Screening Report IIB 4-28
4.3.2 MWRA Residuals Management Facilities Plan IIB 4-28

4.3.3 Massachusetts DEP IIB 4-30
4.3.4 Additional Sites IIB 4-30
4.3.5 Summary Disposal Site Inventory IIB 4-31

4.4 SITE SCREENING PROCESS IIB 4-31
4.4.1 Site Requirements And Screening Criteria IIB 4-32
4.4.2 Disposal Program Planning Considerations IIB 4-36

4.5 BENEFICIAL USE OF NATIVE CLAY AND TILL IIB 4-36
4.5.1 Volume IIB 4-37
4.5.2 Transport Modes IIB 4-37
4.5.3 Disposal Sites IIB 4-38

Table Of Contents - Part II (Cont.)

Page

4.6 DISPOSAL OF ACCEPTABLE DREDGED MATERIAL IIB 4-40
- 4.6.1 Volume IIB 4-40
- 4.6.2 Transport Modes IIB 4-41
- 4.6.3 Disposal Sites IIB 4-41

4.7 DISPOSAL OF UNACCEPTABLE DREDGED MATERIAL IIB 4-42
- 4.7.1 Volume IIB 4-42
- 4.7.2 Transport Modes IIB 4-42
- 4.7.3 Disposal Sites IIB 4-42

4.8 DISPOSAL OF FILL AND UNSORTED CLAY AND TILL IIB 4-43
- 4.8.1 Volume IIB 4-43
- 4.8.2 Transport Modes IIB 4-43
- 4.8.3 Disposal Sites IIB 4-44
- 4.8.4 Description Of Existing Conditions At Potential Disposal Sites IIB 4-57
- 4.8.5 Environmental Impacts Of Potential Disposal Sites IIB 4-91

4.9 COMPARISON OF ENVIRONMENTAL IMPACTS OF ALTERNATIVE DISPOSAL APPROACHES IIB 4-127
- 4.9.1 Introduction IIB 4-127
- 4.9.2 Comparison Of Marine Sites IIB 4-129
- 4.9.3 Description Of Alternative Disposal Approaches IIB 4-130
- 4.9.4 Key Impact Issues For Comparing Disposal Approaches IIB 4-135
- 4.9.5 Environmental Impacts Of Alternative Disposal Approaches IIB 4-145
- 4.9.6 Costs IIB 4-150
- 4.9.7 Summary Of Comparison Of Alternative Disposal Approaches IIB 4-150

4.10 THE PROPOSED ACTION IIB 4-151

4.11 POTENTIAL SUPPLEMENTARY DISPOSAL UNDER INVESTIGATION AT LOGAN AIRPORT IIB 4-152

C OTHER DESIGN REFINEMENTS IIC-1

D FURTHER DESIGN MODIFICATIONS CURRENTLY UNDER CONSIDERATION IID-1

PART III

SECTION 4(f) EVALUATION

Page

1 INTRODUCTION III-1

2 PARKLANDS III-2

2.1 AREA NORTH OF CAUSEWAY STREET III-2
2.1.1 Proposed Action And Other Schemes Considered In The SEIS/R III-2
2.1.2 Leverett Circle/Storrow Drive (Charles River Esplanade) III-3
2.1.3 Designated MDC Nashua Street Parkland III-6
2.1.4 MDC Parkland At The Former GSA Site III-7
2.1.5 Paul Revere Landing Park III-7
2.1.6 Avoidance Alternatives III-11
2.1.7 Overall Comparison Of Impacts Of Area North Of Causeway Street Design Options On 4(f) Parkland III-11
2.1.8 Measures To Minimize Harm To 4(f) Parkland Resources In The Area North Of Causeway Street III-16

2.2 EAST BOSTON MEMORIAL STADIUM PARK III-21
2.2.1 Proposed Action III-21
2.2.2 Description Of The Section 4(f) Property III-22
2.2.3 Impacts On Section 4(f) Property III-23
2.2.4 Avoidance Alternatives III-25
2.2.5 Measures To Minimize Harm III-26

2.3 SPECTACLE ISLAND III-27
2.3.1 Proposed Action III-27
2.3.2 Description Of The Section 4(f) Property III-27
2.3.3 Impacts On The Section 4(f) Property III-29
2.3.4 Avoidance Alternatives III-29
2.3.5 Measures To Minimize Harm III-30

2.4 OTHER NEARBY PARKLANDS NOT USED OR AFFECTED III-30
2.4.1 Lester J. Rotch Playground, South End III-30
2.4.2 Pagoda Park, Chinatown/Leather District III-31
2.4.3 Gateway Park, Chinatown III-31
2.4.4 Christopher Columbus Park, Downtown Waterfront III-31
2.4.5 Union Park And Curley Memorial Park, Haymarket Area III-32
2.4.6 John S. Flaherty Park, South Boston III-32
2.4.7 Bird Island Flats Park, East Boston/Logan Airport III-33
2.4.8 Porzio Park, East Boston III-33
2.4.9 Battleship Park, South Boston III-33

Table Of Contents - Part III (Cont.)

Page

3 HISTORIC RESOURCES III-34

3.1 CHARLES RIVER BASIN HISTORIC DISTRICT III-35
- 3.1.1 Proposed Action III-35
- 3.1.2 Description Of The Section 4(f) Property III-35
- 3.1.3 Impacts On The Section 4(f) Property III-35
- 3.1.4 Avoidance Alternatives III-35
- 3.1.5 Measures To Minimize Harm III-36

3.2 CAUSEWAY/NORTH WASHINGTON STREETS HISTORIC DISTRICT III-36
- 3.2.1 Proposed Action III-36
- 3.2.2 Description Of The Section 4(f) Property III-36
- 3.2.3 Impacts On The Section 4(f) Property III-36
- 3.2.4 Avoidance Alternatives III-37
- 3.2.5 Measures To Minimize Harm III-37

3.3 FORT POINT CHANNEL HISTORIC DISTRICT III-37
- 3.3.1 Proposed Action III-37
- 3.3.2 Description Of The Section 4(f) Property III-38
- 3.3.3 Impacts On The Section 4(f) Property III-39
- 3.3.4 Avoidance Alternatives III-40
- 3.3.5 Measures To Minimize Harm III-41

4 ARCHAEOLOGICAL RESOURCES III-42

5 COORDINATION III-43

List Of Figures

PART I

Figure No.	Title	After Page
1.1	Central Artery Congestion	1-4
1.2	Regional Highway System	1-6
1.3	Study Area	1-6
1.4	Proposed Action - Central Artery/Tunnel Project	1-6
1.5	Potential State And Federal Permits And Approvals	1-10
2.1	Proposed Action - Central Artery/Tunnel Project	2-2
2.2	Existing Facilities Diagram	2-2
2.3	Proposed Facilities Diagram	2-2
2.4	Project Subareas Key Plan	2-2
2.5	Area North Of Causeway Street Alignment	2-4
2.6	Area North Of Causeway Street Section	2-4
2.7	Area North Of Causeway Street Major Traffic Movements	2-4
2.8	Central Area Alignment	2-4
2.9	Central Area Surface Street Alignment	2-4
2.10	Central Area Sections	2-6
2.11	Central Area Major Traffic Movements	2-6
2.12	I-93/I-90 Interchange And Massachusetts Avenue Interchange Area Alignment	2-6
2.13	I-93/I-90 Interchange And Massachusetts Avenue Interchange Area Sections A-A And B-B	2-6
2.14	I-93/I-90 Interchange And Massachusetts Avenue Interchange Area Section C-C	2-6

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
2.15	I-93/I-90 Interchange And Massachusetts Avenue Interchange Area Major Traffic Movements	2-8
2.16	South Boston/South Boston Bypass Road Area Alignment (Northern Area)	2-8
2.17	South Boston/South Boston Bypass Road Area Sections A-A And B-B (Northern Area)	2-8
2.18	South Boston/South Boston Bypass Road Area Alignment (Southern Area)	2-8
2.19	South Boston/South Boston Bypass Road Area Sections C-C And D-D (Southern Area)	2-8
2.20	South Boston/South Boston Bypass Road Area Major Traffic Movements (Northern Area)	2-8
2.21	South Boston/South Boston Bypass Road Area Major Traffic Movements (Southern Area)	2-8
2.22	Third Harbor Tunnel Area Alignment	2-8
2.23	Third Harbor Tunnel Area Typical Section	2-10
2.24	Third Harbor Tunnel Area Major Traffic Movements	2-10
2.25	East Boston/Logan Airport Area Alignment	2-10
2.26	East Boston/Logan Airport Area Sections	2-10
2.27	East Boston/Logan Airport Area Major Traffic Movements	2-10
2.28	Major Design Revisions Since 1985 FEIS/R	2-10
3.1	Transportation Study Area	3-2
3.2	Regional Highway System	3-2
3.3	Mainline Highway Segments - Existing	3-6
3.4	Local Traffic Operations - Existing	3-10
3.5	Existing South Boston Truck Routes 1990	3-18

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
3.6	Inflammable Cargo Truck Routes	3-18
3.7	Structure Of The Forecasting Process	3-26
3.8	2010 Future Baseline Cordon Crossings: AM And PM Peak Hours; 24 Hours	3-36
3.9	2010 Proposed Action Cordon Crossings: AM And PM Peak Hours; 24 Hours	3-36
3.10	Proposed Action Highway Links, Ramps And HOV's - Area North Of Causeway Street	3-36
3.11	Proposed Action Highway Links, Ramps And HOV's - Central Area	3-36
3.12	Proposed Action Highway Links, Ramps And HOV's - I-93/I-90 Interchange And Mass. Ave. Interchange Area	3-36
3.13	Proposed Action Highway Links, Ramps And HOV's - So. Boston/So. Boston Bypass Road Area	3-36
3.14	Proposed Action Highway Links, Ramps And HOV's - So. Boston/So. Boston Bypass Road Area	3-36
3.15	Proposed Action Highway Links, Ramps And HOV's - East Boston/Logan Airport Area	3-36
3.16	Average Weekday Traffic Volumes On Major Highway Links	3-36
3.17	Screenline Crossings	3-40
3.18	Overview Of Traffic Operating Conditions: 2010 Baseline And Proposed Action	3-56
3.19	Intersection Analysis Sites	3-60
3.20	2010 Future Baseline - Surface Artery AWDT Volumes	3-68
3.21	2010 Proposed Action - Surface Roadway AWDT Volumes	3-68
3.22	Hours Of Congestion: 1987, 2010 Baseline And 2010 Proposed Action	3-72

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
3.23	Permanent Parking Impacts And Replacement Sites	3-90
3.24	New Pedestrian Connections	3-96
4.1	Location Of Mobile Source Air Quality Analysis Sites	4-12
4.2 (a) & (b)	Mobile Source Receptor Analysis Sites - East Boston Toll Plaza	4-12
4.3	Affected Zones For Meso Scale Air Quality Analysis	4-20
4.4	Ventilation Building Locations	4-48
4.5	Location Of Receptor Sites For Vent Bldg. No. 3 (Boston Edison) Wind Tunnel Study	4-56
4.6	Location Of Receptor Sites For Vent Bldg. No. 4 (Parcel 7) Wind Tunnel Study	4-56
5.1	Noise Receptor Locations In Project Subareas	5-4
5.2	Location Of Noise Barrier Analyses - Area North of Causeway Street	5-26
5.3	Location Of Noise Barrier Analyses - Central Area	5-28
5.4	Location Of Noise Barrier Analyses - I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	5-28
5.5	Location Of Noise Barrier Analyses - South Boston And South Boston Bypass Road Area	5-28
5.6	Location Of Noise Barrier Analyses - East Boston/Logan Airport Area	5-30
5.7	Vibrations Measurement Locations	5-30
6.1	Total Energy Consumption By Vehicles	6-2
7.1	Boston Metropolitan Area	7-2
7.2	Population/Employment Trends In The Boston New England County Metropolitan Area	7-2
7.3	Employment In The Boston Metropolitan Area	7-2

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
7.4	Economic Analysis Subareas	7-2
7.5	Distribution Of Floor Space Use In Study Area, 1987	7-6
7.6	Distribution Of Boston Employment By Sector, 1980 And 1988	7-6
7.7	Mix Of Retail Sales	7-10
7.8	Mode Of Access To Shopping Districts	7-10
7.9	Distribution Of New Industrial Construction In Metropolitan Boston (NECMA) 1988	7-14
7.10	Central Area Building Area, 1987	7-24
7.11	Distribution Of Central Area Employment, 1987	7-24
7.12	Current Office Tenant Mix In Downtown Boston And Suburbs 1988	7-36
7.13	Projected Tourism Expenditures For Greater Boston Area	7-50
8.1	Major Land Use Changes Since 1983 - Project Area	8-4
8.2	Major Land Use Changes Since 1983 - Downtown	8-4
8.3	Area North Of Causeway Street	8-4
8.4	Central Area	8-4
8.5	Central Area	8-8
8.6	Chinatown/South Cove	8-8
8.7	I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	8-8
8.8	South Boston	8-10
8.9	East Boston/Logan Airport	8-14
8.10	Land Use Impacts - Permanent Facilities	8-16
8.11	Land Use Impacts - Area North Of Causeway Street	8-18

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
8.12	View Of Mainline And Charles River Bridges	8-20
8.13	Land Use Impacts - Central Area	8-24
8.14	Plan Of Parcel 7 And Proposed Action With Surrounding Area	8-24
8.15	Aerial View Of The North End, Government Center And Haymarket	8-24
8.16	Perspective Of Financial District	8-26
8.17	Land Use Impacts - I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	8-30
8.18	Perspective Of Chinatown	8-30
8.19(a)	Land Use Impacts - South Boston/South Boston Bypass Road (Northern Area)	8-32
8.19(b)	Land Use Impacts - South Boston/South Boston Bypass Road (Southern Area)	8-32
8.20	Land Use Impacts - East Boston/Logan Airport Area	8-38
8.21	Perspective Of Expanded East Boston Memorial Stadium	8-38
8.22	Illustrative Parkland Development Concept, Area North Of Causeway Street	8-40
9.1	Visual Characteristics - Area North Of Causeway Street	9-2
9.2	Visual Characteristics - Central Area	9-2
9.3	Visual Characteristics - Central Area	9-2
9.4	Visual Characteristics - Central Area	9-2
9.5	Visual Characteristics - I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	9-4
9.6	Visual Characteristics - South Boston And South Boston Bypass Road Area	9-4
9.7	Visual Characteristics - East Boston/Logan Airport Area	9-6

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
9.8	Key Map Of Perspective Drawings	9-8
9.9	CANA Model And Proposed Action Model	9-8
9.10	North Station - Charles River Pedestrian Connection	9-8
9.11	View of Charles River Looking West	9-8
9.12	View of Charles River Looking East	9-8
9.13	Motorists' View From Charles River Bridge	9-10
9.14	Massachusetts Avenue And Southeast Expressway Gateway Into Central Boston	9-10
9.15	Aerial View Of Expanded East Boston Memorial Stadium	9-10
9.16	Viaduct Design And South Boston Tunnel Portal	9-12
9.17	Model Of Tunnel Interiors	9-12
9.18	Tunnel Interiors	9-12
9.19	Central Area - Haymarket	9-14
9.20	Central Area - Broad Street And Rowes Wharf Arch	9-14
9.21	Beach Street At Chinatown	9-14
9.22	Vent Buildings 1 And 2	9-16
9.23	Vent Building 3 - Boston Edison Site, Atlantic Avenue	9-16
9.24	Vent Building 6 (South Boston) And Vent Building 7 (East Boston)	9-18
10.1	Historic Resources - Central Artery/Tunnel Project	10-2
10.2	Historic Resources - Affected Properties Area North Of Causeway Street Alignment	10-8
10.3	Historic Resources - Affected Properties Central Area Alignment	10-10

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
10.4	Historic Resources - Affected Properties I-93/I-90 Interchange And Massachusetts Avenue Interchange Area Alignment	10-14
10.5	Historic Resources - Affected Properties South Boston And South Boston Bypass Road Area Alignment	10-16
10.6	New Created Parcels In The Central Area	10-16
11.1	Archaeological Test Sites	11-2
11.2	North End Archaeological Study Block	11-4
12.1	Before And After Utility Relocation Program	12-4
12.2	Schematic Plan Of Existing And Proposed Utility Network	12-4
13.1	Project Area Water Bodies	13-2
13.2	Fort Point Channel Location Map	13-2
13.3	Fort Point Channel Core Sample Locations	13-8
13.4	Inner Harbor Location Map	13-8
13.5	Tidal Excursion	13-12
13.6	Location Of Environmental Borings In Boston Inner Harbor	13-14
13.7	Polyaromatic Hydrocarbon (PAH) Sampling Stations	13-14
13.8	Location Of Charles And Millers Rivers	13-16
13.9	Millers River Sampling Stations	13-18
13.10	Major Users Of Boston Harbor Water	13-24
13.12	Locations Of Activities In The Water	13-26
13.13	Proposed And Existing Outfall Locations	13-26
13.14	Proposed Roadway Drainage Areas Schematic	13-26
13.15	Proposed Structures: Fort Point Channel	13-26

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
13.16	Plan, Profile, And Cross-Section Of Seaport Access Road And I-90 Tunnel Box	13-28
13.17	Proposed Structures And Fill: Boston Inner Harbor	13-32
13.18	Proposed Structures And Fill: Charles And Millers Rivers	13-32
13.19	Bridge Pier Locations For The Proposed Charles River Crossing	13-32
13.20	Location Of Tunnel Sections	13-34
14.1	Locations Of Activities In The Water	14-4
14.2	Location Of Charles And Millers Rivers	14-4
14.3	Water Quality Features In The Charles And Millers Rivers	14-4
14.4	Pier A - Charles River Bridge	14-4
14.5	Views Of Charles River	14-8
14.6	Views Of Millers River	14-8
14.7	Millers And Charles Rivers Inland Wetlands	14-8
14.8	Fort Point Channel Location Map	14-12
14.9	Typical Fort Point Channel Coastal Banks	14-14
14.10	Resource Areas And Sampling Locations At Fort Point Channel	14-14
14.11	Inner Harbor Location Map	14-16
14.12	Barge Navigational Channel Area	14-48
14.13	Charles And Millers River Fill: 1985 vs. 1989	14-52
14.14	Fort Point Channel Fill: 1985 vs. 1989	14-52
14.15	Boston Inner Harbor Fill: 1985 vs. 1989	14-52
15.1	Locations Of Activities In The Water	15-2
20.1	Project Structures	20-2

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
20.2	Depressed Central Artery Construction Sequence	20-2
20.3	Third Harbor Tunnel Construction Sequence	20-4
20.4	Concrete Batch Plant	20-6
20.5	Barge Loading Facility	20-6
20.6	Cross-Lot Bracing Construction Example - Downtown Seattle Transit Project	20-8
20.7	Casting Basin	20-10
20.8	Conveyor Belt Examples	20-10
20.9	Project Construction Schedule	20-10
20.10	Construction Sites (By Year)	20-10
20.11	Design Contract Packages	20-14
20.12	Construction Management Organization	20-14
20.13	Construction Management Organization - Management Consultant	20-16
20.14	Detours And Diversions - Stages 1 Thru 5 Area North Of Causeway Street	20-18
20.15	Detours And Diversions - Stage 1 Central Area	20-20
20.16	Detours And Diversions - Stages 1 And 2 Central Area	20-20
20.17	Detours And Diversions - Stages 3 Thru 5 Central Area	20-20
20.18	Detours And Diversions - Stages 1 And 2 I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	20-24

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
20.19	Detours And Diversions - Stages 3 Thru 5 I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	20-24
20.20	Detours And Diversions - Stages 1 Thru 5 South Boston And South Boston Bypass Road Area	20-24
20.21	Detours And Diversions - Stages 1 Thru 6 East Boston/Logan Airport Area	20-26
20.22	Traffic Conditions Identified For Potential Mitigation	20-28
20.23	Potential Pedestrian Impact Locations	20-28
20.24	Affected Subway And Commuter Railroad Facilities	20-30
20.25	Barge Movement In Boston Harbor	20-36
20.26	Estimated Construction Spending Impacts	20-38
20.27	Construction Workforce	20-38
20.28	Average Annual Value Of Demand For Industrial Supplies Resulting From Construction	20-42
20.29	Typical Transverse Utility Corridor	20-52
20.30	Representative Sites For Construction Noise Impact Assessment	20-62
20.31	Suspended Sediments	20-74
20.32	CANA Ramp (Example Of A Temporary Ramp)	20-88
20.33	Temporary Panel Bridge	20-88
20.34	Typical Barge	20-88
20.35	Integrated Pest Management Zones And Activities	20-90
20.36	Construction Mitigation During Three Project Phases	20-94
20.37	Construction Mitigation Example	20-94
20.38	Construction Mitigation Through A Typical Main Intersection	20-94

List Of Figures - Part I (Cont.)

Figure No.	Title	After Page
20.39	Pedestrian Mitigation Example	20-96
20.40	Aerial View of Pedestrian Connection During Construction - Haymarket Area	20-96
20.41	Entrance To Construction Period Pedestrian Path - Haymarket Area	20-96

PART IIB

1.1	Existing Environment In The Area North Of Causeway Street Without I-93 Interchange	IIB 1-6
1.2	Families Of Roadway Options	IIB 1-8
1.3	Option 5A Modified	IIB 1-16
1.4	Option S Modified	IIB 1-16
1.5	Option T Modified	IIB 1-16
1.6	Option Z Modified	IIB 1-16
1.7	Option 5A Modified, Peak Hour Volumes And Weave Analysis	IIB 1-24
1.8	Option S Modified, Peak Hour Volumes And Weave Analysis	IIB 1-24
1.9	Option T Modified, Peak Hour Volumes And Weave Analysis	IIB 1-24
1.10	Option Z Modified, Peak Hour Volumes And Weave Analysis	IIB 1-24
1.11	Area North Of Causeway Street Noise Receptor Locations	IIB 1-42
1.12	Pier Locations In Charles River, 5A Modified And S Modified	IIB 1-50
1.13	Pier Locations In Charles River, T Modified And Z Modified	IIB 1-50
1.14	Impacts To Existing And Proposed Open Space For 5A Modified, S Modified, T Modified, And Z Modified	IIB 1-56
1.15	Aerial View Of I-93/Route 1 Interchange By Option, Looking East	IIB 1-58

List Of Figures - Part IIB (Cont.)

Figure No.	Title	After Page
1.16	Aerial View Of I-93/Route 1 Interchange By Option, Looking West	IIB 1-58
1.17	Views Of I-93/Route 1 Interchange by Option, Looking East From Science Park Station	IIB 1-60
1.18	Views Of I-93/Route 1 Interchange By Option, Looking East From North Point Area, Cambridge	IIB 1-62
1.19	Views Of I-93/Route 1 Interchange By Option, Looking West From Paul Revere Landing Park, North Bank	IIB 1-62
1.20	Views Of I-93/Route 1 Interchange By Option, From Charlestown Residential Area, Looking Southwest	IIB 1-64
1.21	Relocation Impacts for 5A Modified, S Modified, T Modified and Z Modified	IIB 1-64
1.22	Location Of Test Borings In Charles River	IIB 1-76
1.23	Cofferdam Staged Construction Phase 1, Charles River Tunnel	IIB 1-78
1.24	Cofferdam Staged Construction Phase 2, Charles River Tunnel	IIB 1-78
1.25	Immersed Tube Tunnel, Charles River	IIB 1-78
1.26	Vent Building Locations for 5A Modified, S Modified, T Modified and Z Modified	IIB 1-80
1.27	General Parkland Development Objectives, Area North Of Causeway Street	IIB 1-98
1.28	Location Of Proposed Mitigation Measures, Area North Of Causeway Street	IIB 1-100
1.29	Illustrative Parkland Development Concept, North Of Causeway Street	IIB 1-100
1.30	Illustrative Millers River Relocation Development Concepts	IIB 1-100
1.31	Illustrative Development Concept At Revere Park (South Bank) And Lovejoy Wharf	IIB 1-102
2.1	South Boston Bypass Road Study Schemes	IIB 2-2
2.2	South Boston Haul Road/Bypass Road Alternatives	IIB 2-4

List Of Figures - Part IIB (Cont.)

Figure No.	Title	After Page
2.3	Location of South Boston Haul Road And Present Designated Truck Routes	IIB 2-4
2.4	Location of Sensitive Receptors for Noise	IIB 2-14
3.1	South Boston Toll Plaza	IIB 3-4
3.2	East Boston Toll Plaza	IIB 3-6
3.3	Relocation Impacts - South Boston And South Boston Bypass Road Area	IIB 3-12
3.4	Relocation Impacts - East Boston/Logan Airport Area	IIB 3-12
4.1	Project Construction Areas	IIB 4-8
4.2	Soil Sampling Zones and Selected Boring Locations	IIB 4-20
4.3	Zinc and Copper: Schematic Diagram - Subsurface Profile Soil Characterization	IIB 4-20
4.4	Arsenic: Schematic Diagram - Subsurface Profile Soil Characterization	IIB 4-20
4.5	Lead: Schematic Diagram - Subsurface Profile Soil Characterization	IIB 4-20
4.6	Mercury: Schematic Diagram - Subsurface Profile Soil Characterization	IIB 4-20
4.7	Hydrocarbon: Schematic Diagram - Subsurface Profile Soil Characterization	IIB 4-20
4.8	Quality of Fill: Schematic Diagram - Subsurface Profile	IIB 4-20
4.9	Boston Blue Clay: Schematic Diagram - Subsurface Profile Soil Characterization	IIB 4-22
4.10	Excavation Of Historic Fill At 200 State Street	IIB 4-22
4.11	Disposal Site Screening Report Sites	IIB 4-28
4.12	MWRA Service Area	IIB 4-28

List Of Figures - Part IIB (Cont.)

Figure No.	Title	After Page
4.13	Additional Sites	IIB 4-30
4.14	Massachusetts Bay Disposal Sites	IIB 4-42
4.15	Site BED10 (Bedford)	IIB 4-58
4.16	Bedford Aquatic Resource Areas	IIB 4-58
4.17	Bedford Floodplains	IIB 4-58
4.18	Bedford Vegetative Communities	IIB 4-60
4.19	Site MAL01 (Rowe Quarry)	IIB 4-62
4.20	Malden Site Location Map	IIB 4-62
4.21	Malden Vegetative Communities	IIB 4-62
4.22	Malden Floodplains	IIB 4-64
4.23	Site WEY13 (Weymouth)	IIB 4-66
4.24	Weymouth Floodplains	IIB 4-66
4.25	Weymouth Vegetative Communities	IIB 4-68
4.26	East Brookfield Site	IIB 4-70
4.27	East Brookfield Floodplains	IIB 4-70
4.28	East Brookfield Vegetative Communities	IIB 4-74
4.29	Governors Islands Flats	IIB 4-76
4.30	Hull Bay Disposal Area	IIB 4-78
4.31	Hull Site Location Map	IIB 4-78
4.32	Logan Airport North and West Sites	IIB 4-80
4.33	Logan Airport North And West Sites - Sediment, Water Quality And Biological Sampling Locations	IIB 4-80
4.34	Existing Environmental Conditions On Spectacle Island	IIB 4-84

List Of Figures - Part IIB (Cont.)

Figure No.	Title	After Page
4.35	Spectacle Island Resource Areas	IIB 4-84
4.36	Spectacle Island	IIB 4-84
4.37	Hypothesized Limits Of Sediment Contaminants	IIB 4-86
4.38	Spectacle Island Aquatic Resource Areas	IIB 4-88
4.39	Site BED10: Landfill Footprint	IIB 4-100
4.40	Site WEY13: Landfill Footprint	IIB 4-99
4.41	East Brookfield Site: Landfill Footprint	IIB 4-102
4.42	Proposed Spectacle Island Concept	IIB 4-116
4.43	Spectacle Island Concept Plan	IIB 4-116
4.44	Footprints Of Disposal Alternatives At Spectacle Island	IIB 4-148
4.45	Potential Areas For Leveling At Logan Airport	IIB 4-152

PART IIC

1	I-93 Southbound Off-Ramp To Causeway Street Area	IIC-2
2	I-93 Northbound On-Ramp From Causeway Street Area	IIC-4
3	I-93 Southbound Off-Ramp To Government Center Area	IIC-6
4	I-93 Southbound On-Ramp From Government Center Area And On-Ramps To Callahan Tunnel	IIC-8
5	I-93 Northbound Off-Ramp To Government Center Area	IIC-12
6	I-93 Southbound Off-Ramp To Financial District	IIC-14
7	I-93 Northbound Off-Ramp To Financial District	IIC-16
8	I-93 Northbound On-Ramp From Northern Avenue	IIC-20
9	I-93 Northbound Alignment - South Station Area	IIC-22

List Of Figures - Part IIC

Figure No.	Title	After Page
10	I-93/I-90 Interchange Major Connectors	IIC-24
11	Local Street Reconstruction In I-93/I-90 Interchange	IIC-26
12	Massachusetts Avenue Interchange Area	IIC-30
13	I-90 Mainline Alignment - South Boston	IIC-32
14	Third Harbor Tunnel Alignment - South Boston	IIC-34
15	Logan Airport Interchange - East Boston	IIC-36
16	Connections To Route 1A Northbound - East Boston	IIC-40
17	Connections To MBTA Blue Line Airport Station - East Boston	IIC-42

PART IID

1	Possible Design Refinements Under Consideration - I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	IID-2
2	Possible Design Refinements Under Consideration - South Boston/South Boston Bypass Road	IID-2
3	Possible Design Refinemenets Under Consideration - East Boston/Logan Airport Area Alignment	IID-4

PART III

1	Location Of Parkland Addressed In Section 4(f) Evaluation	III-2
2	Design Options - Area North Of Causeway Street	III-2
3	Section 4(f) Resources Area North Of Causeway Street	III-4
4	Views Of Leverett Circle And Storrow Drive	III-4
5	Use Of The Section 4(f) Resource At Leverett Circle	III-4

List Of Figures - Part III (Cont.)

Figure No.	Title	After Page
6	Views Of Paul Revere Landing Park, South Bank Of River	III-8
7	Views Of Lower Charles River	III-8
8	Use Of Section 4(f) Resource (Paul Revere Landing Park, South Bank)	III-8
9	General Parkland Development Objectives, Area North Of Causeway Street	III-18
10	Location Of Proposed Mitigation Measures, Area North Of Causeway Street	III-20
11	Illustrative Parkland Development Concept, Area North Of Causeway Street	III-20
12	Illustrative Development Concept At Revere Park (South Bank) And Lovejoy Wharf	III-20
13	Illustrative Millers River Relocation Development Concepts	III-20
14	Illustrative View Of Charles River Bridges, Proposed Action	III-20
15	Illustrative View Of Alternative Charles River Bridge Structural Types: Option 8	III-20
16	Illustrative View Of Alternative Charles River Bridge Structural Types: Option 9	III-20
17	Illustrative Improvements To Leverett Circle, Nashua Street Parcel And GSA Site	III-22
18	Existing Parkland, East Boston Memorial Stadium Park	III-22
19	Views Of East Boston Memorial Stadium Park: Facilities For Active Recreation	III-22
20	Views Of East Boston Memorial Stadium Park	III-22
21	Proposed Uses In The Area Of East Boston Memorial Stadium Park	III-24

List Of Figures - Part III (Cont.)

Figure No.	Title	After Page
22	East Boston Memorial Stadium Proposed Landscaping	III-26
23	Location Of Spectacle Island	III-28
24	Spectacle Island Resource Areas	III-28
25	Proposed Spectacle Island Concept	III-30
26	Parkland Unaffected By Proposed Action	III-30
27	Historic Resources Addressed in Section 4(f) Evaluation	III-34

List Of Tables

Table No. **Title** **Page**

PART I

1.1 Design Development To Resolve Outstanding Issues As Identified In The FEIS/R Process 1-2

3.1 Comparison Of 1982 And 1987/88 Average Weekday Traffic Volumes 3-5

3.2 Existing 1987/88 Traffic Conditions Highway Links 3-7

3.3 1987/88 Traffic Conditions At Signalized Intersections 3-11

3.4 1987/88 Traffic Conditions In Ramp Areas 3-13

3.5 Inflammable Materials Trucks In Selected Locations 3-18

3.6 Summary Of Existing And Projected Traffic Conditions 3-25

3.7 Existing And Projected Average Weekday Traffic Volumes 3-28

3.8 Existing And Projected Average Weekday Daily Traffic On Selected Surface Street Links 3-37

3.9 Projected Average Weekday Daily Traffic Screenline Crossings 3-40

3.10 Existing And Projected AM And PM Peak Hour Traffic Volumes 3-41

3.11 Projected Traffic Operations In 2010 3-54

3.12 Traffic Operations At Critical Ramp Areas 3-58

3.13 Projected Traffic Operations At Signalized Intersections 3-61

3.14 Comparison Of Existing And Projected VMT And VHT In Study Area 3-73

3.15 Daily Vehicle Miles Travelled (VMT) By Community And Facility Type for 2010 Build Conditions 3-75

3.16 Daily Vehicle Miles Travelled (VMT) By Community And Facility Type For 2010 No-Build Conditions 3-77

3.17 Daily Vehicle Hours Travelled (VHT) By Community And Facility Type For 2010 Build Conditions 3-79

3.18 Daily Vehicle Hours Travelled (VHT) By Community And Facility Type For 2010 No-Build Conditions 3-81

List Of Tables - Part I (Cont.)

Table No.	Title	Page
3.19	Projected Expressway Accidents And Accident Rates	3-86
3.20	Projected Systemwide Accidents And Accident Rates	3-87
3.21	Permanent Parking Displacements By Proposed Action	3-88
3.22	Comparison Of Transit And Auto Trips To Study Area And Boston Proper, 1987, 2010 Baseline, And 2010 Build	3-92
3.23	Rapid Transit Improvements: MBTA Capital Construction Program	3-100
3.24	Summary Of Estimated HOV Volumes For I-93 Between South Station And Massachusetts Avenue	3-104
4.1	National And State Ambient Air Quality Standards	4-3
4.2	Air Toxics Identified In Vehicle Exhaust	4-5
4.3	Maximum And Second-Highest Hourly Ozone Concentrations Measured In The Boston Metropolitan Area	4-8
4.4	Annual Mean, Maximum Hourly, And Second-Highest Hourly NO_2 Concentrations Measured In The Boston Metropolitan Area (ug/m^3)	4-9
4.5	Maximum And Second-Highest 1-Hour And 8-Hour CO Concentrations Measured In The Boston Metropolitan Area	4-11
4.6	Vehicular Operating Conditions	4-15
4.7	Carbon Monoxide Background Levels	4-16
4.8	Estimated 1-Hour And 8-Hour Worst Case Carbon Monoxide Levels In 1987 Based On Microscale Modeling	4-17
4.9	Traffic Parameters Used To Estimate Areawide Emission Burdens For The Year 1987	4-20
4.10	Peak Daily Emission Burdens In The Study Area 1987	4-21
4.11	Annual Emission Burdens In The Study Area 1987	4-22
4.12	Estimated 1-Hour Worst Case Carbon Monoxide Levels In 1998 With And Without The Proposed Action	4-24

List Of Tables - Part I (Cont.)

Table No.	Title	Page
4.13	Estimated 8-Hour Worst Case Carbon Monoxide Levels In 1998 With And Without The Proposed Action	4-26
4.14	Traffic Parameters Used To Estimate Areawide Emission Burdens For The Year 1998	4-29
4.15	Peak Daily Emission Burdens In The Study Area 1998	4-30
4.16	Annual Emission Burdens In The Study Area 1998	4-31
4.17	Estimated 1-Hour Worst Case Carbon Monoxide Levels In 2010 With And Without The Proposed Action	4-33
4.18	Estimated 8-Hour Worst Case Carbon Monoxide Levels In 2010 With And Without The Proposed Action	4-35
4.19	Traffic Parameters Used To Estimate Areawide Emission Burdens For The Year 2010	4-38
4.20	Peak Daily Emission Burdens In The Study Area 2010	4-39
4.21	Annual Emission Burdens In The Study Area 2010	4-40
4.22	Proposed Ventilation Building Sites	4-47
4.23	Emission Rates Used In Ventilation Building Impact Analysis	4-49
4.24	Air Quality Prediction Sites For Physical Modeling Of Ventilation Building 3: Boston Edison Site	4-51
4.25	Air Quality Prediction Sites For Physical Modeling Of Ventilation Building 4: Parcel 7	4-53
4.26	Maximum Annual Average NO_2 Concentrations At Ground Level And Elevated Receptor Locations In The Vicinity Of Proposed Ventilation Buildings Based On Analytical (ISCLT) Modeling Results	4-57
4.27	Maximum 1-Hour And 8-Hour CO Concentrations At Ground Level And Elevated Receptor Locations In The Vicinity Of Proposed Ventilation Buildings Based On Analytical (ISCST) Modeling Results	4-58

List Of Tables - Part I (Cont.)

Table No.	Title	Page
4.28	Maximum 1-Hour NO_x and NO_2 Ground Level Concentrations In The Vicinity Of Ventilation Buildings 1, 2, 5, 6, and 7 Based On The Results Of Analytical (ISCST) Modeling	4-60
4.29	Second-Highest Hourly Total NO_2 Concentrations By Wind Direction Resulting From Emissions From Ventilation Building 3, Boston Edison Site Based On The Results Of Physical Modeling	4-61
4.30	Second-Highest Hourly Total NO_2 Concentrations By Wind Direction Resulting From Emissions From Ventilation Building 4, Parcel 7 Site Based On The Results Of Physical Modeling	4-63
4.31	Maximum Predicted Ground Level Concentrations Of NO_2 And CO At All Ventilation Buildings Based On The Results Of Analytical Modeling	4-65
4.32	Maximum Predicted Concentrations Of NO_2 And CO At Elevated Receptors At All Ventilation Buildings Based On The Results Of Analytical Modeling And Wind Tunnel Studies	4-67
5.1	Federal Highway Administration Noise Abatement Criteria	5-3
5.2	Comparison Of Predicted Noise Levels With Existing Levels: Area North Of Causeway Street [in L_{eq}(1 Hour) dBA]	5-4
5.3	Comparison Of Predicted Noise Levels With Existing Levels: Central Area [in L_{eq}(1) dBA]	5-5
5.4	Comparison Of Predicted Noise Levels With Existing Levels: I-93/I-90 Interchange And Massachusetts Avenue Interchange Area [in L_{eq}(1 Hour) dBA]	5-6
5.5	Comparison Of Predicted Noise Levels With Existing Levels: South Boston/South Boston Bypass Road Area [in L_{eq}(1 Hour) dBA]	5-7
5.6	Comparison Of Predicted Noise Levels With Existing Levels: East Boston/Logan Airport Area [in L_{eq}(1 Hour) dBA]	5-8
5.7	Variation Of Hourly L_{eq} Over A 24-Hour Period At The Callahan/Sumner Tunnel Toll Plaza (Site 14)	5-10
5.8	Variation Of Hourly L_{eq} Over A 24-Hour Period At Harbor Tower Building (Site 22)	5-11

List Of Tables - Part I (Cont.)

Table No.	Title	Page
5.9	Variation Of Hourly L_{eq} Over A 24-Hour Period At Stillman And Endicott Street Residences (Site 31)	5-12
5.10	Variation Of Hourly L_{eq} Over A 24-Hour Period At Flaherty Park (Site 34)	5-13
5.11	Variation Of Hourly L_{eq} Over A 24-Hour Period At 25-31 West Fifth Street, South Boston (Site 35)	5-14
5.12	Comparison Of Predicted Noise Levels [in L_{eq}(1 Hour) dBA] With FHWA Criteria: Area North Of Causeway Street	5-17
5.13	Comparison Of Predicted Noise Levels [in L_{eq}(1 Hour) dBA] With FHWA Criteria: Central Area	5-18
5.14	Comparison Of Predicted Noise Levels [in L_{eq}(1 Hour) dBA] With FHWA Criteria: I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	5-19
5.15	Comparison Of Predicted Noise Levels [in L_{eq}(1 Hour) dBA] With FHWA Criteria: South Boston/South Boston Bypass Road Area	5-20
5.16	Comparison Of Predicted Noise Levels [in L_{eq}(1 Hour) dBA] With FHWA Criteria: East Boston/Logan Airport Area	5-21
5.17	Ventilation Noise Assessment Summary	5-24
5.18	Project Vibration Criteria	5-31
5.19	Summary Of Existing Vibration Measurement	5-32
6.1	Annual Energy Consumption By Vehicles	6-2
6.2	2010 Build Condition: Annual Energy Consumption For Roadway Support Systems In Millions Of Btu	6-4
6.3	Indirect Construction Energy Consumption: 2010 Proposed Action Condition	6-4
7.1	Employment In The Boston Metropolitan Area	7-3
7.2	Study Area Land Use And Employment (1986)	7-6
7.3	Distribution Of Private Employment By Zip Codes In The City Of Boston Portion Of The Study Area	7-7

List Of Tables - Part I (Cont.)

Table No.	Title	Page
7.4	Occupants Of Offices In Downtown Boston	7-10
7.5	Mix Of Retail Sales	7-11
7.6	Mode Of Access To Shopping Districts	7-11
7.7	Annual Construction Of Industrial Facilities In Metropolitan Boston (NECMA) 1980-1988	7-14
7.8	Vacancy Rates For Metropolitan Boston Industrial Space	7-15
7.9	Manufacturing Employment In Boston 1977-1985	7-16
7.10	Year-Round Residential Units In The Study Area By Neighborhood	7-17
7.11	Visitors To Greater Boston	7-19
7.12	Purpose Of Visits To Greater Boston (1985)	7-19
7.13	Direct Expenditures By Visitors In Greater Boston (1985)	7-21
7.14	Direct Expenditures In Boston Area By Lodging Type (1985)	7-22
7.15	Tourism-Related Employment In The Boston Area (1985)	7-22
7.16	Central Area Land Use And Employment (1986)	7-24
7.17	Summary Of Long-Term Economic Impacts (Year 2010)	7-27
7.18	Suffolk County And Metro Area Employment Growth Forecasts	7-29
7.19	Study Area Land Use And Employment Forecast	7-31
7.20	Long-Term Retail Sales Impacts Due To The Artery/Tunnel Project	7-32
7.21	Projected Tourism Activity Under Baseline And Proposed Action	7-46
7.22	Total Suffolk County And Metro Employment In Year 2010	7-52
7.23	Long-Term (Year 2010) Annual Fiscal Impacts Of The Proposed Action On the Commonwealth Of Massachusetts	7-55
8.1	Major Land Use Changes Since 1983 In Area North Of Causeway Street	8-3

List Of Tables - Part I (Cont.)

Table No.	Title	Page
8.2	Major Land Use Changes Since 1983 In Central Area	8-5
8.3	Major Land Use Changes Since 1983 In I-93/I-90 Interchange And Massachusetts Avenue Interchange Area	8-9
8.4	Major Land Use Changes Since 1983 In South Boston And South Boston Bypass Road Area	8-11
8.5	Major Land Use Changes Since 1983 In East Boston/Logan Airport Area	8-13
8.6	Land Use Impacts In Area North Of Causeway Street	8-19
8.7	Land Use Impacts In Central Area	8-22
8.8	Land Use Impacts In I-93/I-90 Interchange and Massachusetts Avenue Interchange Area	8-28
8.9	Land Use Impacts in South Boston/South Boston Bypass Road Area	8-33
8.10	Land Use Impacts On Massport Property	8-35
8.11	Land Use Impacts On EDIC Property	8-36
8.12	Land Ownership In East Boston/Logan Airport Right-of-Way	8-38
10.1	Status Of Historic Resources In The Vicinity Of The Artery/ Tunnel Project	10-2
10.2	New Parcels Subject To Joint Development Design Guidelines For Historic Preservation	10-6
12.1	Miles Of Major Utility Relocations By Subarea	12-3
13.1	Commonwealth Of Massachusetts Water Quality Standards	13-3
13.2	Existing Water Quality In Fort Point Channel	13-6
13.3	Fort Point Channel Sediment Analysis	13-9
13.4	Benthic Organisms In Project Right-Of-Way In Fort Point Channel	13-10
13.5	Existing Water Quality In Boston Inner Harbor	13-12

List Of Tables - Part I (Cont.)

Table No.	Title	Page
13.6	Bulk Sediment Characteristics Near The Third Harbor Tunnel Alignment	13-14
13.7	Polyaromatic Hydrocarbon Concentrations In The Third Harbor Tunnel Alignment	13-15
13.8	Existing Water Quality In Lower Charles River	13-18
13.9	Summary Of Measurement Of Millers River Water Quality Parameters	13-19
13.10	Dissolved Oxygen And Temperature Measurements In The Millers River	13-20
13.11	Lower Charles River Sediment Analysis	13-21
13.12	Millers River Sediment Quality	13-22
13.13	Industrial Seawater Use In The Boston Harbor Area	13-24
14.1	Constraints To Navigation In Fort Point Channel And Charles River	14-9
14.2	Major Existing Piers And Berths In The Vicinity Of Project Activities	14-10
14.3	Industrial Seawater Use In The Boston Harbor Area	14-17
14.4	Species List Of Boston Inner Harbor Marine Benthic Macroinvertebrates	14-20
14.5	Boston Inner And Outer Harbor Finfish Species List	14-22
14.6	Functional Evaluation Summary	14-25
14.7	Criteria For Functions And Values Assessment	14-26
14.8	Artery/Tunnel Projectwide Fill Volumes And Areas 1985 FEIS/R And 1989 SEIS/R	14-31
14.9	Proponent's Factual Determination: Millers River (Nontidal)	14-35
14.10	Proponent's Factual Determination: Charles River (Nontidal)	14-36
14.11	Proponent's Factual Determination: Fort Point Channel	14-44

List Of Tables - Part I (Cont.)

Table No.	Title	Page
14.12	Proponent's Factual Determination: Boston Inner Harbor	14-50
18.1	Relationship Of The Proposed Action To Other Projects	18-3
20.1	Summary Of Economic Impacts Of Construction	20-37
20.2	Expenditures On Labor, Materials, And Equipment	20-39
20.3	Direct, Indirect, And Induced Impacts On Sales And Jobs In Suffolk County	20-40
20.4	Direct, Indirect, And Induced Impacts On Sales And Jobs In The Region	20-41
20.5	Estimated Local Impacts For Establishments Adjacent To The Central Artery	20-45
20.6	Construction Phase Annual Fiscal Impacts: Commonwealth Of Massachusetts	20-47
20.7	Truck Requirements By Subarea	20-56
20.8	Background TSP Levels For Concrete Batch Plant	20-58
20.9	Gaseous Emission Rates For Concrete Batch Plant	20-60
20.10	Typical Noise Levels From Construction Equipment	20-62
20.11	Maximum Predicted Construction Noise Levels	20-64
20.12	Criteria For Annoyance Due To Groundborne Vibration In Buildings	20-66
20.13	Typical Vibration Levels Due To Construction Equipment And Traffic At 100-Foot Distance	20-68
20.14	Historic Buildings And Structures Within 110 Feet Of Pile Driving Activities	20-71
20.15	Nonhistoric Buildings Within 60 Feet Of Pile Driving Activities	20-72

List Of Tables - Part IIB

Table No. **Title** **Page**

PART IIB

Table No.	Title	Page
1.1	Artery/Tunnel Project Design Criteria	IIB 1-5
1.2	Summary Of Advantages And Disadvantages Of The Options	IIB 1-25
1.3	Traffic Operations Summary	IIB 1-27
1.4	Weaving Section Level Of Service Summaries	IIB 1-28
1.5	Highway Ramp Junction Operations - Mainline Volume And Lane 1 Volume At Merge (PCPH)	IIB 1-29
1.6	Summary Of Intersection Operations	IIB 1-30
1.7	Peak Hour Traffic Operations At The Intersection Of Causeway Street And Surface Artery	IIB 1-31
1.8	Estimated Peak Hour Travel Times And Speeds On Mainline	IIB 1-32
1.9	Estimated Peak Hour Travel Times And Speeds On Leverett Circle/Storrow Drive Connectors	IIB 1-33
1.10	Estimated Queues And Queue Speeds	IIB 1-34
1.11	Comparison Of VHT And VMT Measures (Entire Project Study Area)	IIB 1-35
1.12	Comparison Of VHT And VMT Measures (Downtown And Area North Of Causeway Street Districts)	IIB 1-35
1.13	Annual Air Quality Emissions Burden For Carbon Monoxide (Tons Per Year) Year: 2010	IIB 1-38
1.14	Annual Air Quality Emissions Burden For Hydrocarbons (Tons Per Year) Year: 2010	IIB 1-39
1.15	Annual Air Quality Emissions Burden For Nitrogen Oxides (Tons Per Year) Year: 2010	IIB 1-40
1.16	Predicted Worst-Case 8-Hour Carbon Monoxide Levels In Year 2010 For The Four Options North Of Causeway Street	IIB 1-42
1.17	Factors Resulting In Aquatic Impacts	IIB 1-46

List Of Tables - Part IIB (Cont.)

Table No.	Title	Page
1.18	Open Space And Parkland Summary Of Long-Term Impacts By Option	IIB 1-54
1.19	Relocations Required In The Area North Of Causeway Street	IIB 1-64
1.20	Comparison Of Roadway Characteristics By Roadway Link	IIB 1-84
1.21	Comparison Of Traffic Operations	IIB 1-86
1.22	Comparison Of Long-Term Environmental Impacts	IIB 1-88
1.23	Comparison Of Construction Period Impacts	IIB 1-91
1.24	Evaluation Of Options Relative To Design Objectives	IIB 1-93
2.1	Comparative Volumes On Selected Highway Links	IIB 2-8
2.2	Weaving Analysis	IIB 2-10
2.3	Intersection Level of Service Andrew Square Approaches	IIB 2-11
2.4	I-93/I-90 Ramp Connections	IIB 2-13
2.5	Predicted Worst Case 1-Hour Carbon Monoxide Levels In 2010	IIB 2-15
2.6	Predicted Worst Case 8-Hour Carbon Monoxide Levels In 2010	IIB 2-16
2.7	Annual Air Quality Emissions Burden for South Boston in Year 2010	IIB 2-17
2.8	Peak Hour Noise Levels At Locations Affected By The South Boston Bypass Road Alternatives	IIB 2-18
3.1	Estimated Average Westbound Traffic Speeds (MPH) In PM Peak Hour, Year 2010	IIB 3-8
3.2	Predicted Worst-Case 8-Hour Carbon Monoxide Levels Under Each Toll Plaza Alternative	IIB 3-11
4.1	Comparison Of Methods And Materials Movement Options By Construction Area	IIB 4-12
4.2	Materials Quantities By Construction Area	IIB 4-17

List Of Tables - Part IIB (Cont.)

Table No.	Title	Page
4.3	Classification Of Material By Chemical Constituents	IIB 4-18
4.4	Summary Of Statistical Analysis Of Selected Soil Constituents	IIB 4-20
4.5	Estimated Composition of Fill Materials	IIB 4-23
4.6	Disposal Site Screening Report Sites	IIB 4-29
4.7	Practicability Screening Criteria	IIB 4-33
4.8	Active Coastal Landfills	IIB 4-39
4.9	Disposal Site Screening Summary	IIB 4-51
4.10	DEP Solid Waste Landfill Siting Criteria	IIB 4-53
4.11	Summary Of Potential Materials Disposal Sites That Met Initial Screening Criteria	IIB 4-56
4.12	Potential Aquatic Impacts For Proposed Spectacle Island	IIB 4-122
4.13	Summary of Initial Impacts On Combined Aquatic Resource Areas	IIB 4-128
4.14	Aquatic Resource Area Impacts In Potential Disposal Sites	IIB 4-137
4.15	Comparison Of Resulting Conditions Associated With Various Spectacle Island Approaches	IIB 4-138
4.16	Comparison Of Net Impacts Associated With Various Spectacle Island Approaches	IIB 4-139
4.17	Summary Of Direct Impacts To Environmental Conditions Of Potential Disposal Sites	IIB 4-142
4.18	Composite Of Disposal Sites/Impacts	IIB 4-148

PART III

Table No.	Title	Page
2.1	Section 4(f) Parkland Impact Summary Area North Of Causeway Street	III-14

HWA-MA-EIS-82-02-DS2

CENTRAL ARTERY (I-93)/
THIRD HARBOR TUNNEL (I-90) PROJECT

DRAFT

SUPPLEMENTAL

ENVIRONMENTAL IMPACT STATEMENT/REPORT AND SUPPLEMENTAL FINAL SECTION 4(f) EVALUATION

PART II

- Project Changes And Refinements Since 1985 FEIS/R

Federal Highway Administration
Massachusetts Department of Public Works

Part IIA – Introduction

Part IIA

INTRODUCTION

Part II of the Central Artery (I-93)/Third Harbor Tunnel (I-90) Project SEIS/R describes project changes which have been developed since the 1985 FEIS/R. Part IIB is a detailed analysis of four project elements that evolved after the FEIS/R. They are:

- o Area North of Causeway Street
- o South Boston Bypass Road
- o Toll Plaza Locations
- o Materials Disposal

These elements differ from other project components which have been updated since the FEIS/R in that they involve relatively large elements of local, State, or Federal agencies, during the coordination process subsequent to the FEIS/R. Part IIB describes the alternative approaches considered, reviews their environmental impacts, and compares the; alternative approaches for each of the four elements.

Part IIC contains a brief geographical summary of 17 other design refinements developed since the FEIS/R. Part IID briefly discusses further design modifications to the Proposed Action currently under discussion.

PART IIB ANALYSIS OF ALTERNATIVE DESIGN OPTIONS

Chapter 1 Area North Of Causeway Street, I-93/Charles River Crossing

This element of the project includes a complicated set of regional highway connections between the Central Artery, Route I-93, Route 1, and Leverett Circle and Storrow Drive, as well as local streets. Providing these connections involves a series of traffic merges and weaves which require relatively long highway segments, but which must occur within a geometrically constrained area. These constraints include the Charles River, existing and planned parks, historic districts and structures, major public and private development at North Station and on both banks of the Charles River, and existing highway and transit structures which must be avoided during construction.

The Massachusetts Department of Public Works pursued, as required by the Executive Office of Environmental Affairs, in its certification of the 1985 FEIS/R, modifications that would reduce the Charles River impacts of the FEIS/R Alternative 5A Modified. A total of 31 options was explored in three families of schemes in which the major differences relate to Storrow Drive connections. They are the viaduct/tunnel family, the Charles River tunnel family, and the viaduct family. Chapter 1 evaluates the most promising representative of each family of alternatives to 5A Modified; they are S Modified, T Modified, and Z Modified (possible bridge options and aspects of an earlier version of Alternative T also are presented). Alternative Z Modified was selected as the recommended alternative and is described in Part I of the FEIS/R as part of the Proposed Action.

Chapter 2 South Boston Bypass Road

The Bypass Road in South Boston is an extension of the construction Haul Road which is the subject of a separate SEIS/R. This analysis and past studies demonstrate the value of such a roadway for commercial vehicles which will have lasting benefits of the South Boston residential community and industrial development of the waterfront. In addition, connection of the Haul Road to the I-93/I-90 system will be beneficial to traffic flow on these interstate highways. Accordingly, two design alternatives are discussed in Chapter 2, a Bypass Road connected to the interstate system and to local streets, and a Local Truck Route which has the local but not the interstate connections. The full Bypass Road was selected and is described in Part I of the SEIS/R as part of the Proposed Action.

Chapter 3 Toll Plaza Locations

The FEIS/R Preferred Alternative located the I-90 toll plaza on Commonwealth Flats in South Boston; this location was viewed as an opportunity to keep the toll facilities as far as possible from residential areas. Upon further development of the project, geometric constraints of the South Boston location were further evaluated, and additional facilities to accommodate high-occupancy vehicles (HOV) were added to the projectwide HOV system. Both of these factors suggested that general traffic flow, safety, and HOV operations could be better accommodated by locating a toll plaza at Logan Airport. Chapter 3 compares these locations from both operational and environmental points of view. It was determined that the air quality and noise impacts of the two alternatives on residential areas are not substantially different. In addition, it was determined that the Logan Airport location solves safety and operations problems and is superior in its capacity to support a long-range strategy to reduce airport traffic through the use of HOVs. The Logan Airport alternative was selected and is described in Part I of the SEIS/R as part of the Propose Action.

Chapter 4 Materials Disposal

Materials disposal options have been studies extensively since the FEIS/R. Chapter 4 includes an analysis of a broad range of disposal sites and options including the ocean, subaqueous sites near Logan Airport, coastal sites, Spectacle Island, and inland sites. These families of sites are evaluated in terms of a variety of environmental and regulatory issues which apply to each, and also in terms of the transportation impacts associated with handling the excavated material and removing it from the project area. Environmental issues and problems associated with ocean disposal also are discussed. The proposed disposal option involves a combination of ocean, Spectacle Island, and inland sites, with most material transported by barge; this option is described in Chapter 20 of Part I of the SEIS/R.

PART IIC OTHER DESIGN REFINEMENTS

Other design refinements since the FEIS/R are summarized in matrix form by project subarea in Part C of Part II.

PART IID FURTHER DESIGN MODIFICATIONS CURRENTLY UNDER CONSIDERATION

Part IID describes several additional design modifications currently under consideration in the continuing design development process. As is the case with all major transportation projects, more detailed design work undertaken as the project progresses typically surfaces other potential design improvements. The particular possible modifications described in Part IID respond to comments from affected communities and public agencies, as well as to recommendations from an independent value engineering analysis of the Proposed Action design by engineers and construction cost estimators.

Part IIB – Analysis Of Alternative Design Options

Chapter 1 – Area North Of Causeway Street

Chapter 1

AREA NORTH OF CAUSEWAY STREET

1.1 INTRODUCTION

The northern end of the Artery/Tunnel Project includes a new crossing of the Charles River to replace the existing high-level bridge, as well as modifications and additions to the Central Artery North Area (CANA) interchange between I-93, Route 1, and connections to Storrow Drive. This subarea of the Artery/Tunnel Project is called the Area North of Causeway Street in the SEIS/R.

The Preferred Alternative for this area described in the 1985 FEIS/R is known as scheme 5A Modified. Serious operational and environmental problems with this design were noted in the FEIS/R or identified following its publication. These included poor traffic operations, shadows over the Charles River dam by the I-93 northbound bridge, impacts to Paul Revere Landing Park in Charlestown, impacts to the MDC's Nashua Street parkland parcel and to the Esplanade along Storrow Drive, partial taking of two historic structures in the North Station area, and loss of service for the connection of Storrow Drive to I-93 north and Route 1 during 2 years of construction.

In order to resolve these problems, the Massachusetts Department of Public Works (the Department) and Federal Highway Administration (FHWA) initiated the development of an improved design for this portion of the Artery/Tunnel Project. Thirty-one roadway design options were drawn by the project engineers. In all of the options, I-93 is carried on new bridges across the Charles River and the CANA ramps provide connections between I-93 and Route 1. Three families of designs were developed for the connections between Storrow Drive and I-93: viaduct/tunnel; Charles River tunnel; and viaduct. The three families are described below. This chapter of the SEIS/R describes four roadway options: the original Preferred Alternative (5A Modified), and three new options which are the most refined versions of the 31 schemes developed, to better answer the many requirements for project operations and to minimize impacts. The chapter also describes the environmental impacts of the four options and provides a comparison of the four options.

1.1.1 Background

Currently, Route 1 traffic follows a path that connects Storrow Drive to the Tobin Bridge via an existing high-level double-deck bridge structure which carries I-93 traffic across the Charles River. Storrow Drive traffic must merge from the left into I-93 northbound traffic, and then separate into I-93 (to the left) and Route 1 traffic (to the right). In the southbound direction, Route 1 traffic merges from the left into I-93 traffic and then quickly separates into I-93 southbound (to the left) and Storrow Drive traffic (to the right). These complicated movements occur within a very short 600-foot-long section of highway causing highway safety problems and traffic backups.

To remedy this short weave distance problem, the Department initiated the CANA project in 1979. In the CANA project design, the distance between the merging and separating of traffic streams will be increased to approximately 1,800 feet. All regional traffic will be accommodated via the existing I-93 double-deck bridge, the double-deck ramp structure behind

North Station, and two new loop ramps west of I-93 in Cambridge. In addition, both local and regional Route 1 traffic will pass beneath City Square in Charlestown via new tunnels south of the Tobin Bridge. The tunnels, a section of both loop ramps, and the relocated approaches to the Tobin Bridge are now under construction and scheduled for completion by November 1992. Current design plans include landscaping in Paul Revere Landing Park, expansion of the Esplanade westward along the Charles River, provision of a pedestrian bridge and paths, improvement of the Millers River, and other landscaping in highway ramp areas. The Metropolitan District Commission (MDC) has long had a commitment to develop an overall master plan for the Lower Charles River area that includes an easterly extension of the Esplanade on the north and south banks of the Charles River toward Boston Harbor.

While the CANA project was in the preliminary engineering phase, the Department initiated an environmental/engineering study for the separate but related Central Artery (I-93)/Third Harbor Tunnel (I-90) Project. The Artery/Tunnel Project FEIS/R Preferred Alternative for this subarea, referred to as scheme 5A Modified, was not able to maintain the distance between movements which were achieved by CANA. The 1,800-foot separation would have been reduced to 1,200 feet in 5A Modified. As described above, this design problem, and a variety of other operational and environmental problems, led to the investigation of other options for the Area North of Causeway Street.

Two documents published prior to this SEIS/R are relevant to the Area North of Causeway Street. In July 1986, the Department refined the FEIS/R Preferred Alternative in a Notice of Project Change (NPC) filed with the Massachusetts Executive Office of Environmental Affairs (EOEA). This project change removed the tunnel ramps from the south bank of the Charles River and placed them in a new location behind North Station and 100 Nashua Street (Registry of Motor Vehicles Building).

A much earlier relevant study is the Department's 1981 Central Artery-Leverett Circle Connection Feasibility Study. This work involved the development of several schemes to provide direct connections for Route 1 traffic between the Tobin Bridge and Leverett Circle/Storrow Drive. These potential schemes consisted of both viaduct and tunnel alternatives. The CANA tunnel design was developed to allow the accommodation of a possible future "Leverett Circle Connection" during the long-range planning process. The Central Artery/Leverett Circle connection was given further consideration during the development of subsequent alignment options within the SEIS/R process.

New And Proposed Public And Private Projects. In addition to the need to address project operational and environmental issues, a number of development and transportation projects in the Area North of Causeway Street have changed substantially or been initiated since the FEIS/R was published. The different roadway schemes discussed in this chapter have been responsive to these changes. Some of the new developments around North Station include the completed relocation of Nashua Street and the construction of a new Suffolk County Jail, scheduled for completion in 1990, on a portion of the former Nashua Street alignment. The Spaulding Rehabilitation Hospital has constructed a four-story building extension and has plans for an additional recreational facility expansion adjacent to the Charles River.

The North Station area has been a focal point for both public and private development projects. The Massachusetts Bay Transportation Authority (MBTA), is in the process of upgrading the commuter rail facility. Improvements will include extension of the tracks toward Causeway Street, high-level platforms with provision for future air rights development, and construction of an underground parking garage containing about 1,400 spaces. The MBTA also will construct a new underground Green Line between Science Park station at Leverett Circle and Haymarket station. All of these activities have been planned in conjunction with the latest development plans for the new sports arena and commercial complex proposed at North Station.

Public open space improvements planned in the area include MDC plans for a new park located on a designated parkland site between new Nashua Street and the Charles River, a new park on the Cambridge side of the river (on land acquired from the GSA), and extension of bicycle and pedestrian paths from the Charles River Esplanade to Paul Revere Landing Park on land currently owned by the Department.

In addition, new proposals for office buildings, a hotel, and a multiple unit housing development in East Cambridge (North Point) recently were presented to City of Cambridge and State officials. One such proposal submitted by Congress Group Ventures is contained in a May 1989 Final Development Plan entitled 15 Monsignor O'Brien Highway prepared for the City of Cambridge Planning Board.

All of these activities have helped to formulate design parameters and identify constraints which are to be accommodated by the options discussed in this chapter.

1.1.2 Design Objectives

The Artery/Tunnel interchange being designed for this area must meet projectwide roadway design objectives addressing the following basic issues:

- Accommodation of traffic flow which meets appropriate highway norms on all mainlines and ramps.
- Provision of a high level of travel safety.
- Conformance to Department and FHWA highway design standards.
- Minimization of environmental impacts.
- Reasonable cost.
- Capability to be constructed safely and with minimal impacts on traffic service during construction.
- Compatibility with new and proposed construction in the area.

The projectwide design objectives listed above must be met in an area with major geometric, geographic, and environmental constraints. The most important of the highway design requirements and locale-specific design considerations are described below. These two sets of design criteria are the basis against which each potential roadway option has been evaluated.

1.1.2(a) Highway Design Requirements

The design of the options identified in this analysis address the criteria established by the Department's Highway Design Manual and the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highways and Bridges. Other relevant standards established by projectwide design guidelines for the Artery/Tunnel Project also apply to the design of the options described in this report.

Where there are differences in design standards between the above publications, the more stringent standards usually have been applied. Elements from these documents were formulated into a single project statement entitled Central Artery (I-93)/Tunnel (I-90) Project Design Criteria Section III-Civil. (Some of the key design parameters included among the project design criteria are listed in Table 1.1.)

While the objective of this analysis was to develop a practical revision to the FEIS/R 5A Modified plan that would resolve outstanding issues, it should be recognized that no option was found that fulfilled every highway design requirement. Notwithstanding the extremely constrained conditions of the project area, three options were developed that satisfactorily meet a number of design requirements. These three are improvements over 5A Modified, and with greater or lesser success resolve its outstanding issues.

1.1.2(b) Connections To Be Made By The Interchange

The interchange which comprises the Area North of Causeway Street is very complicated because it must accommodate 16 distinct traffic moves. These are:

- I-93 mainline - northbound
- I-93 mainline - southbound
- I-93 northbound to Storrow Drive westbound
- I-93 southbound to Storrow Drive westbound
- I-93 northbound to Route 1 eastbound
- I-93 southbound to Route 1 eastbound
- I-93 northbound to North Station area streets
- I-93 southbound to North Station area streets
- Storrow Drive eastbound to I-93 northbound
- Storrow Drive eastbound to I-93 southbound
- Storrow Drive eastbound to Route 1 eastbound
- Route 1 westbound to Storrow Drive westbound
- Route 1 to I-93 northbound
- Route 1 to I-93 southbound
- North Station area streets to I-93 northbound
- North Station area streets to I-93 southbound

As this long list makes clear, the interchange can be neither simple nor small. Each of the required moves carries a substantial volume of traffic, and none can be eliminated from the system [see Section 1.1.3(a) below].

1.1.2(c) Location-Specific Design Considerations For The Area North Of Causeway Street

The specific design considerations for the interchange reflect applicable roadway design standards and respond to the environmental constraints within which the roadway will be constructed. (Figure 1.1 illustrates the Area North of Causeway Street and shows the many constraints within which the project must fit.)

Table 1.1

ARTERY/TUNNEL PROJECT DESIGN CRITERIA

Roadway Type	Design Speed (mph)	Stopping Sight Distance (ft) Minimum/Desirable	Minimum Radius (ft)	Profile Grade (%) Maximum/Desirable
Mainline	50	400/475	850	5/3
Ramps				
Loop	25	150/150	185	7/5
Other	30	200/200	275	
Minor Arterials	40	275/325	275	7/5
City Streets	30	200/200	100	8/5

Vertical Clearances:	
Structures over open highways	14.5 feet
Central Artery tunnel	14.0 feet
Leverett Circle tunnel	14.0 feet
Railroad clearance (Massachusetts State Statute)	22.5 feet
Charles River bridges (above mean high water)	30.0 feet
Mainline Minimum Weave Distance	1,000 feet

Source: Bechtel/Parsons Brinckerhoff

The following list of design objectives is a combination of highway design requirements and location specific constraints to the roadway's geometry and alignment.

- Accommodate all of the required highway and local street connections [see list in Section 1.1.2(b)].
- Maintain 50-mph design speed on main lines.
- Maintain 25-mph design speed on all ramps.
- Maximize separation of the following key movements:
  - On-ramp (northbound) from the Sumner Tunnel and the off-ramp to Storrow Drive.
  - On-ramp from Storrow Drive and the off-ramp to the Callahan Tunnel.
  - Northbound on-ramp from Storrow Drive and the off-ramp to Route 1.
  - Southbound on-ramp from the Tobin Bridge and the off-ramp to Storrow Drive.
- Maintain all major traffic connections throughout the construction period.
- Minimize modifications to the Green Line relocation project.
- Minimize impacts to the CANA project contracts now under construction.
- Minimize impacts to existing parkland and proposed open space along the Charles River.
- Minimize impacts to the Charles and Millers Rivers.
- Minimize project impacts to existing facilities including Boston Sand & Gravel, Boston Thermal, and the Massachusetts Water Resources Authority (MWRA) pumping station.
- Minimize impacts to the planned Boston Garden development.
- Minimize impacts to the operations of North Station commuter rail and MBTA (Green Line and Orange Line), both existing and future.
- Minimize limitations on future air-rights opportunities over the North Station commuter railroad facilities.
- Minimize impacts to the North Point area of Cambridge.

Among the highway design criteria which have critical importance to the design of the Area North of Causeway Street are those addressing merges and weaves on the highway mainline. The creation of adequate distances between the on-ramp from the Sumner Tunnel and the off-ramp to Storrow Drive, and between the on-ramp from Storrow Drive and the off-ramp to the Callahan Tunnel, have been the specific and central design issues addressed during the exploration of different options. In order to create a safe highway at design speeds of 50 mph on the mainline, the distances between these entrances and exits must be maximized.

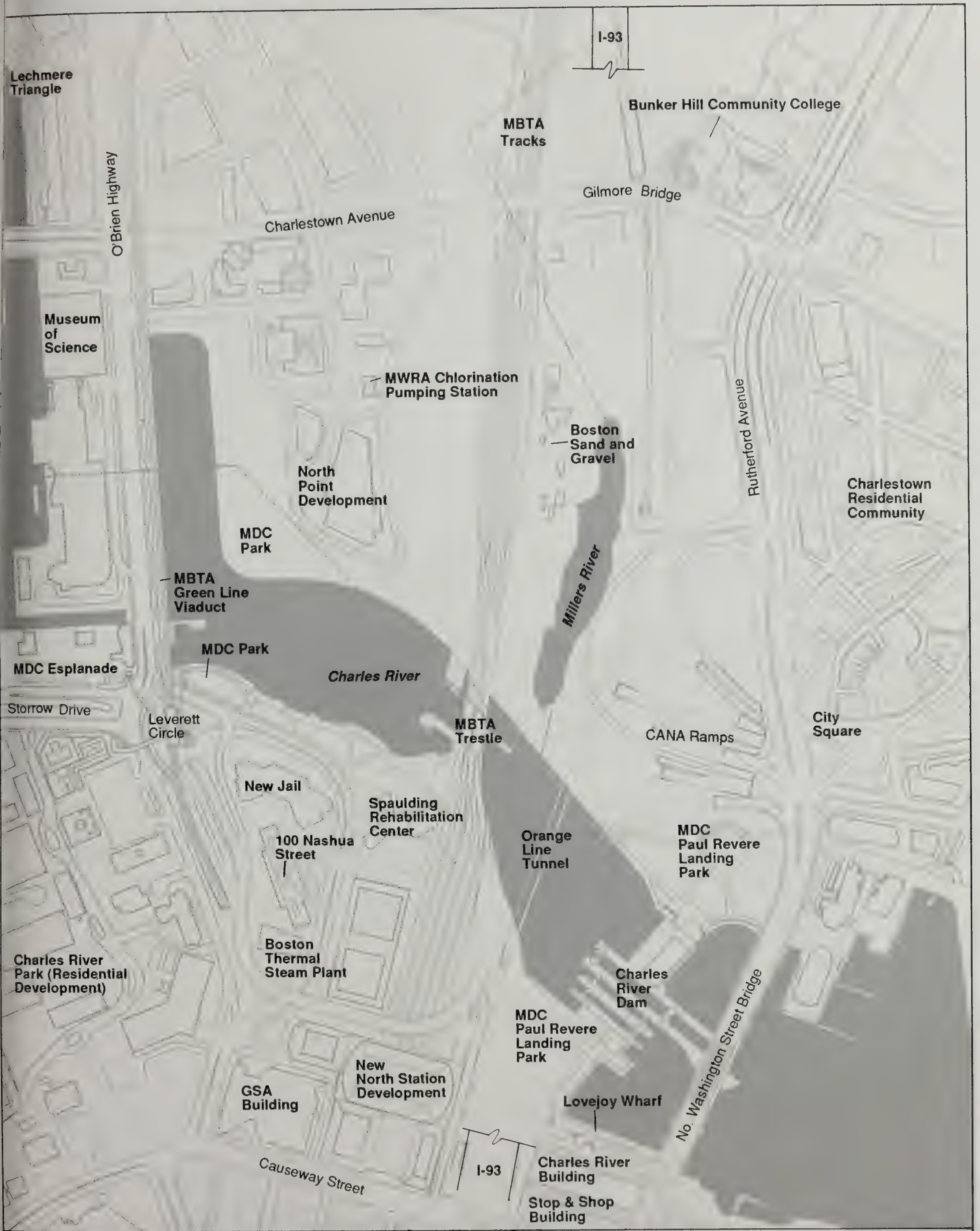


FIGURE 1.1

Environment In The Area North Of Causeway Street Without I-93 Interchange

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 200 400 800 Feet

1.1.3 Evolution Of Roadway Options

As noted above, in order to identify the roadway option which best meets the design considerations, the Department developed 31 different options for the interchange, all of which belong to one of three basic families. The three basic families of options are illustrated in Figure 1.2 and described below.

Viaduct/Tunnel Concept --"A" Family: This family includes options in which Leverett Circle/Storrow Drive connections with I-93 south of Causeway Street are made via tunnels behind North Station. Leverett Circle/Storrow Drive connections to and from I-93 north of Causeway Street are placed on viaducts via the same corridor.

Charles River Tunnel Concept --"M" Family: This family includes options in which Leverett Circle/Storrow Drive connections to and from I-93 north of Causeway Street are within tunnels beneath the Charles River. Leverett Circle/Storrow Drive connections with I-93 south of Causeway Street are made via tunnels behind North Station, as in the "A" Family.

Viaduct Concept --"E" Family: This family includes options in which all Leverett Circle/Storrow Drive connections with I-93 are made via viaducts behind North Station which are connected to bridges over the Charles River and thence to the loop ramps on the north side of the Charles River.

Within each family, many different designs were explored. As a design was refined, each distinct iteration received a new designation. The 28 schemes which were not designated for further analysis are Schemes "A," "A Modified," "B," "C," "D," "E," "F," "G," "H," "J," "K," "L," "M," "N," "O," "P," "Q," "Q Modified," "R," "U," "V," "W," "X," "Y," "AA," "BB," "CC," and "DD." These schemes were dropped from further study due to significant geometric, operational, and constructibility problems.

The options selected for further study represent the results of an iterative design process which improved the designs by addressing the problems discovered as each scheme was evaluated. The three schemes which represent the most refined design for each family were finally determined to be appropriate for detailed environmental and operational assessment. This chapter describes these three designs in detail, and compares their impacts with regard to traffic/transportation, environmental impacts, and constructibility. The final section of this chapter compares the options.

A fourth scheme is discussed in this chapter as well, the 1985 FEIS/R Preferred Alternative -- which is the appropriate base for all comparisons. In summary, the schemes compared and evaluated here are the following:

Option 5A Modified. This is the Preferred Alternative from the FEIS/R and is treated as the base case for the build alternative. 5A Modified falls within the Viaduct/Tunnel Family.

Option S Modified. This is the refined design of the Viaduct/Tunnel Family.

Option T Modified. This is the refined design of the Charles River Tunnel Family.

Option Z Modified. This is the refined design of the Viaduct Family.

1.1.3(a) Other Options Considered But Determined Not To Be Feasible

A number of options with very different characteristics from those which are evaluated in this document have been discussed over the many years of design development preceding and following the 1985 FEIS/R. Several of them deserve a brief review to describe why they have not been carried further into the design process.

I-93 Mainline In Tunnel Under The Charles River. Due to the elevation of I-93 north of the Charles River, the depth of tunnel required to pass beneath the navigation channel in the Charles, and the location of the Orange Line tunnel beneath the Charles, it was determined that an "all tunnel" option is not geometrically feasible. That is, grades would either be far too steep, or the length of I-93 that would require reconstruction would extend too far north (approximately to Sullivan Square, Somerville) for the concept to be feasible. Furthermore, a connection to the Tobin Bridge would be impossible.

Highway Designs Which Do Not Include All Of The Connections. Options which did not include explicit connections between all of the roadways have been explored. In particular, eliminating a direct connection between Storrow Drive and I-93 south of Causeway Street has been reviewed. The possibility of diverting traffic to the Massachusetts Turnpike for connection to I-93 at the I-90/I-93 Interchange was explored. However, a major portion of Storrow Drive traffic enters the system from Route 2 or from points east of the Massachusetts Turnpike Allston interchange and therefore could not be diverted.

Additionally, the possibility of providing no direct highway link from Storrow Drive to I-93 south of Causeway, but rather directing traffic to local streets for access to downtown and the Sumner/Callahan Tunnels, was studied. The volume of traffic diverted to local streets, however, would place all local intersections at unacceptable level of service (LOS F) conditions and would cause very significant congestion on downtown streets.

None of these options is practicable regarding traffic service and local traffic circulation; none of the specific connections can be excluded from the interchange design.

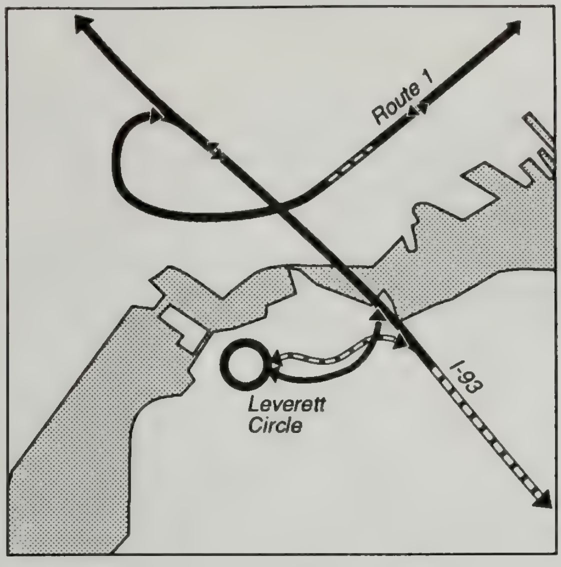
1.2 DESCRIPTION OF OPTIONS

This section of the chapter provides a description of the four options: 5A Modified, S Modified, T Modified, and Z Modified. The mainline, connections between Storrow Drive and I-93, connections to local streets, and conformance to highway design and criteria are described for each option. (Figures 1.3 to 1.6 show the options.)

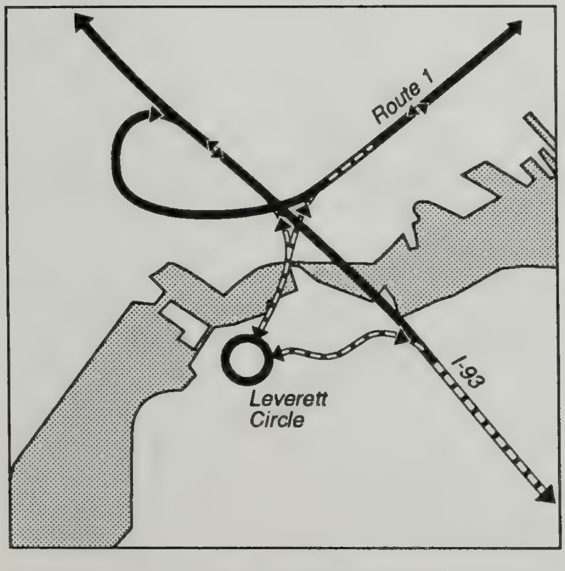
1.2.1 Option 5A Modified

The I-93 mainline is located on a split bridge alignment on either side of the existing bridge (which will be removed). I-93 northbound is four lanes wide as it transitions from tunnel to viaduct north of Causeway Street. A one-lane on-ramp for local traffic destined to points north merges onto the mainline from the right just south of the Charles River.

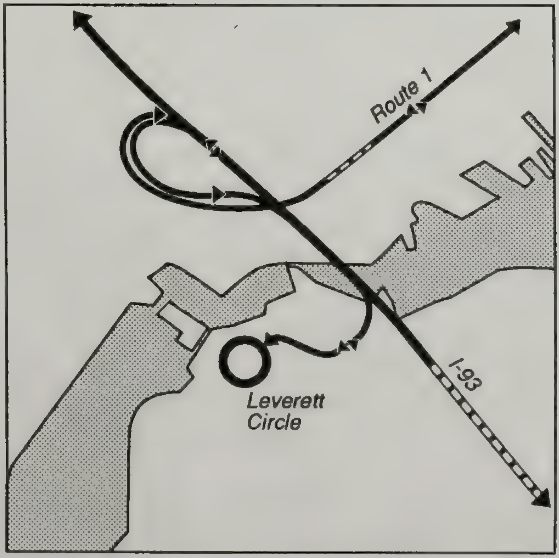
Viaduct/Tunnel Concept
'A' Family



Charles River Tunnel Concept
'M' Family



Viaduct Concept
'E' Family



LEGEND

▬ Viaduct
▭ Tunnel

FIGURE **1.2**

Families of Roadway Options

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

(Not To Scale)

Within 800 feet all traffic is squeezed into four lanes to allow for a one-lane left-hand entrance ramp connection from Storrow Drive. I-93 northbound passes over the locks of the Charles River dam and Paul Revere Landing Park (see Figure 1.3).

Five lanes continue north on I-93 for a distance of about 1,400 feet before two lanes exit from the left and join CANA Ramp C-T carrying traffic destined for Route 1 and Charlestown. (Option 5A Modified results in a shorter weave section on I-93 northbound than the 1,800 feet that the CANA project will achieve.)

I-93 southbound is a three-lane facility as it crosses over the Gilmore Bridge. Subsequently, it is joined on the right by a two-lane entrance ramp from Route 1 and local Charlestown streets. As I-93 crosses the Charles River, two lanes of traffic destined for Storrow Drive or the North Station area exit from the right. I-93 southbound continues as four lanes and is joined on the right by a one-lane entrance ramp from Storrow Drive prior to entering a tunnel under Causeway Street as a five-lane facility.

Storrow Drive - I-93 Connections. The connections between Storrow Drive and I-93 south of Causeway Street are located in tunnels along the south bank of the Charles River. The tunnels are located within a narrow 80-foot-wide corridor which passes beneath the North Station commuter railroad tracks. (This alignment of the tunnels along the banks of the river was identified by EOEA during the FEIS/R process as an issue of critical environmental concern.)

The connections between Storrow Drive and I-93 north of Causeway Street are located on two viaducts along Martha Way/Lomasney Street. The two viaducts span the commuter rail tracks behind North Station near the existing double-deck viaduct and join I-93 near the north bank of the Charles River.

Leverett Circle is retained as a signalized rotary with access to the Central Artery and points north.

Local Connections. Local access to/from the north is provided via on-and off-ramps at Causeway Street.

Conformance to Highway Design Criteria.

- o Two problem weave sections occur along the I-93 northbound mainline. South of Causeway Street, the mainline weave length between the Sumner Tunnel on-ramp and Storrow Drive off-ramp is approximately 750 feet, which is considerably below the norm. North of Causeway Street two weave sections exist between the Causeway Street on-ramp and Route 1 off-ramp and between the Storrow Drive on-ramp and Route 1 off-ramp. Weave lengths are approximately 2,000 feet and 1,400 feet, respectively. Although these lengths meet the minimum criterion (1,000 feet), the introduction of multiple weaves, with one comprising a right-hand entrance followed by a left-hand exit, results in congested and unsafe mainline operations.

- o Southbound, I-93 mainline weave sections exist between the Route 1 southbound on-ramp and Storrow Drive/downtown off-ramp and between the Storrow Drive on-ramp and the Callahan Tunnel off-ramp. Respective weave lengths are approximately 1,200 feet and

1,150 feet. Again, although these lengths meet the minimum criterion, traffic cannot be efficiently accommodated within these lengths on the former because of its high traffic volumes. The weave section between the entering ramp from the CANA project and the off-ramp to Storrow Drive (1,200 feet) is considerably shorter than that which will exist upon completion of the CANA project.

- The maximum mainline grade criterion of 5 percent is exceeded in option 5A Modified more than in any other option. Both mainline profiles were developed with 6 percent grades. Despite speed reductions exceeding normal limits, no provision for climbing lanes is made. The steep 6 percent grade on I-93 northbound compounds the problem created by multiple weave sections of the highway.

- In the North Station area, the tunnel ramp connections between the Central Artery and Storrow Drive incorporate the use of transition curves where physically possible. The ramp alignments have been developed to accommodate a 30-mph design speed. Since the viaduct connections to/from the north use the existing ramp structure, the design speeds of this location are governed accordingly and, therefore, do not exceed 25 mph. Due to horizontal controls, special signs address recent FHWA concerns regarding safe truck operations at interchanges.

- The I-93 northbound and southbound mainline roadways across the Charles River do not comply with project highway design criterion for shoulder widths. Twelve-foot travel lanes are provided with 1-foot mainline shoulders. This inadequate shoulder width makes no provision for potential breakdowns. Consequently, mainline capacity will be jeopardized, and serious congestion can be anticipated when breakdowns occur.

- Vertical clearances are controlled by existing sight constraints at the Leverett Circle underpass and double-deck viaduct near the Boston Thermal building. The 14-foot vertical clearance restriction at these locations does not meet the current project requirement of a 14.5-foot minimum.

1.2.2 Option S Modified

Option S Modified is the refined version of option 5A Modified, which addresses the geometric and operational deficiencies of that design and the problem of ramps in the Charles River.

Mainlines. The I-93 mainlines are on a parallel bridge alignment with the northbound and southbound mainlines located to the west of the existing I-93 double-deck structure over the Charles River (see Figure 1.4).

I-93 northbound emerges from tunnel just north of Causeway Street and continues as a four-lane facility as it crosses the Charles River. As the highway approaches the north bank of the Charles River, two lanes exit to the right carrying traffic destined for Route 1 or local streets. Three lanes continue as I-93 northbound.

Travelling into Boston, I-93 southbound is a three-lane facility as it crosses the Gilmore Bridge. The mainline is joined on the right by the two-lane CANA Ramp T-C carrying traffic from Route 1. This five-lane facility transitions to four lanes as it crosses the Charles River and enters a tunnel portal at Causeway Street.

Storrow Drive - I-93 Connections. S Modified provides direct connections between Storrow Drive and I-93 south of Causeway Street via tunnels that are located parallel to the existing double-deck viaduct behind North Station/Boston Garden. The connection between Storrow Drive and I-93 southbound is provided via a one-lane ramp in tunnel. The entrance of this tunnel to I-93 southbound is located beneath Lomasney Street. I-93 northbound traffic destined for Storrow Drive is accommodated by a two-lane off-ramp with an exit located in tunnel beneath Causeway Street.

A unique feature of this option is that regional connections between Storrow Drive and points north are accommodated by a new eastbound underpass at Leverett Circle and a double-deck structure located west of and parallel to the proposed I-93 southbound bridge over the Charles River. The upper deck of this new structure carries two lanes of traffic northbound from Storrow Drive to I-93/Route 1, while the lower deck carries two lanes of traffic southbound in the return movement. This configuration eliminates the mainline weaves on the I-93 northbound and southbound bridges over the Charles River.

Local Connections. Access to the north from downtown Boston streets is provided via on-ramps at Leverett Circle or Causeway Street. Local access into the North Station area from the north is provided via off-ramps at Causeway Street.

Conformance To Highway Design Criteria.

- The Sumner Tunnel entrance ramp to I-93 northbound is followed by two successive exit ramps: the first to Storrow Drive and the second to Route 1. This configuration results in two mainline weaves approximately 750 feet and 2,500 feet in length, respectively. (The shorter weave does not meet the minimum criterion (1,000 feet) for mainline weaves. A one-lane entrance followed by two-lane exit (referred to as a Type B configuration) is provided to help increase efficiency in carrying large weaving volumes.)

- The I-93 southbound mainline configuration also produces two weave sections along the highway. The Callahan Tunnel off-ramp from I-93 southbound is preceded by two successive entrance ramps -- the first from Storrow Drive and the second from Route 1. The resulting weave lengths are 850 feet and 3,000 feet, respectively. As is the case for I-93 northbound, the shorter weave does not meet the minimum criterion for mainline weaves. A Type B configuration is provided at this weave section of highway as well.

- A ramp weave exists in this option on the connection between Storrow Drive and Route 1. The weave on Route 1 southbound from the I-93 on-ramp to the Causeway Street off-ramp, is approximately 1,200 feet in length. This condition is acceptable for the roadway classification of Route 1 southbound, and does not therefore constitute a major weave problem.

- Option S Modified exceeds the maximum mainline grade and critical length of grade criteria. Profile constraints at both Causeway Street and the navigational channel in the Charles River, combined with 12-foot maximum bridge depths, result in a 5.3 percent mainline grade across the Charles River. Although speed reductions on I-93 northbound will exceed the maximum allowable, no climbing lane is provided since vehicles are able to use adjacent lanes to pass slower moving vehicles.

- Where sight conditions are favorable, transition curves are provided on all ramp connections. Transition curves exist, for the most part, in the CANA project area as well. In the North Station area, the tunnel ramp connections to/from Storrow Drive use transition curves where feasible; however, the viaduct ramp connections only conform to existing site conditions. Design speeds for these Storrow Drive ramp connections do not exceed 25-mph. The loop ramps in the area north of the Charles River meet project criteria, providing a minimum 25-mph design for all single-lane ramps and a minimum 30-mph design for two-lane ramps.

- Ramp radii, although in conformance with FHWA design criteria, do not conform to a recent FHWA guideline which suggests using a minimum radius of 300 feet (where conditions allow) to accommodate trucks at 25 mph. Since the minimum radius in the loop area in this option is approximately 225 feet, special design features including advance signing for trucks may be warranted.

- Both mainline roadways provide 12-foot travel lanes with 4-foot shoulders on the left and 10-foot shoulders on the right.

1.2.3 Option T Modified

Mainlines. The I-93 mainlines are on a parallel bridge alignment with both the northbound and southbound roadways located to the west of the existing double-deck structure over the Charles River (see Figure 1.5).

I-93 northbound is four lanes wide as it emerges from the portal at Causeway Street and crosses the Charles River. At the south bank of the Charles, it is joined by a northbound on-ramp from Causeway Street. At the north bank, a two-lane exit ramp diverges to the right and carries traffic to Route 1. I-93 northbound continues as a three-lane facility and ties into the existing structure at approximately the Gilmore Bridge.

I-93 southbound is a three-lane facility as it crosses the Gilmore Bridge. It is subsequently joined on the right by a two-lane ramp carrying traffic from Route 1. The highway crosses the Charles River as a five-lane facility. At about the south bank of the Charles River, a two-lane ramp exits on the right to carry traffic destined for local connections at North Washington and Causeway Streets. I-93 southbound continues as a four-lane facility as it enters into tunnel under Causeway Street.

Storrow Drive - I-93 Connections. The Storrow Drive connections with I-93 south of Causeway Street are located in tunnels parallel to the existing double-deck viaduct behind North Station/Boston Garden. The ramp from I-93 northbound to Storrow Drive continues in tunnel section below the Boston Thermal steam plant site. A single-lane local ramp diverges from the right and carries traffic to the Nashua Street area, while the tunnel ramp continues as a single-lane facility and ties into the existing westbound underpass at Leverett Circle.

The return move is provided by a ramp directing eastbound traffic from Storrow Drive into a single-lane tunnel facility along Lomasney Street. After crossing underneath the MBTA railroad tracks, the ramp joins the I-93 southbound mainline on the right under Causeway Street as a one-lane entrance ramp.

The connections between Storrow Drive and I-93 and Route 1 north of Causeway Street are made via tunnels under the Charles River. The northbound tunnel splits into a tunnel that ultimately joins I-93 northbound 1,000 feet beyond the Gilmore Bridge and a boat section that enters directly into the tunnel portal of the CANA project at City Square in Charlestown. This northbound tunnel originates at Storrow Drive as a one-lane tunnel, which is subsequently joined on the right by a one-lane local on-ramp carrying traffic from Merrimac Street/Lomasney Street. The roadway continues as a two-lane tunnel, passing about 150 feet to the north of the bascule bridge. A right-hand ramp carries traffic to I-93 north and one lane ties into the Route 1 northbound CANA tunnel under City Square.

The I-93 southbound movement to Storrow Drive takes off from the mainline about 1,000 feet north of the Gilmore Bridge and enters into tunnel near the bridge. This tunnel is joined by a direct connection exiting from the CANA tunnel at City Square in Charlestown which emerges from the City Square CANA tunnel in transition and enters into tunnel 500 feet further west. Continuing in a southerly direction, the tunnel passes under the Charles River as a two-lane facility and tapers to one lane as it reaches Leverett Circle and joins the existing westbound underpass, beneath the Circle.

Local Connections. I-93 northbound access to the tunnel from Storrow Drive is provided via a new underpass beneath Leverett Circle and a tunnel connecting with Merrimac Street providing local access from this area. Additional local access to the north from downtown Boston is provided via a Causeway Street on-ramp. Local access into the North Station area from points north is provided via an off-ramp to Causeway Street.

Conformance To Highway Design Criteria.

- The I-93 southbound mainline configuration produces a weave section along the highway between the on-ramp from Storrow Drive and the off-ramp to Callahan Tunnel. The weave length is 850 feet, which is below the FHWA minimum criterion of 1,000 feet.
- The I-93 northbound mainline configuration produces a short weaving section, 750 feet in length, between the Sumner Tunnel on-ramp and the Storrow Drive off-ramp.
- The northbound tunnel under the Charles River includes a weaving section 1,170 feet long between the Merrimac Street on-ramp and the split to I-93 northbound and Tobin Bridge ramps.
- Option T Modified exceeds the maximum mainline grade and critical length of grade criteria. Profile constraints at both Causeway Street and the navigational channel in the Charles River, combined with 12-foot maximum bridge depths, result in approximately 5.3 percent mainline grades over the river. Although speed reductions on I-93 northbound exceed the maximum allowable, no climbing lane is provided since vehicles are able to use adjacent lanes to pass slower moving vehicles.
- The tunnels between Storrow Drive and Route 1 are designed for 40 mph. The maximum profile grades in the Route 1 northbound and southbound tunnel approaches are 6 percent and 5 percent, respectively.
- In this option, the design of the proposed I-93 mainlines for the most part will provide 12-foot travel lanes with 4-foot shoulders on the left and 10-foot shoulders on the right.

- o The ramp connecting Causeway Street to I-93 northbound and Route 1 northbound is a two-lane facility separated from I-93 northbound by a safety shaped barrier which allows traffic to either merge with Route 1 traffic or continue northerly to I-93.

1.2.4 Option Z Modified

Mainlines. The mainlines of this option are on a parallel bridge alignment west of the existing Charles River bridge (see Figure 1.6). I-93 northbound is five lanes wide as it emerges from tunnel at Causeway Street and transitions to six lanes while crossing the Charles River. In addition, there is a two-lane on-ramp from Traverse Street which is parallel to the mainline on the same structure; one lane continues north to I-93 and one lane goes to Route 1. A major fork in the mainline occurs as the roadway crosses the Charles River. At the fork, three lanes lead to I-93 north, and three lanes lead to Route 1/Storrow Drive.

I-93 southbound is three lanes wide as it crosses the Gilmore Bridge. Two lanes of traffic from Route 1 then enter the mainline on the right and I-93 southbound continues as a five-lane facility, as it enters into tunnel under Causeway Street.

Storrow Drive - I-93 Connections. All Storrow Drive to I-93 connections are made via loop ramps north of the Charles River.

Option Z Modified provides the Storrow Drive to I-93 southbound connection via a ramp which passes beneath Leverett Circle and follows the alignment of Lomasney Street. The ramp then continues across the Charles River as the upper level of a double-deck structure located parallel and west of I-93 southbound. As the ramp approaches the north bank of the Charles River, a second ramp exits from the left and follows the alignment of the CANA loop ramps around, reversing direction, before joining I-93 southbound at the north bank of the Charles River. This configuration allows for the elimination of the short I-93 southbound weave south of Causeway Street that is common to the other three options.

The short I-93 northbound weave south of Causeway Street is eliminated by incorporating an additional off-ramp north of the Charles River which loops around the CANA ramps, reverses direction, continues as the lower deck of the double-deck structure adjacent to I-93 southbound, and ultimately connects to the existing underpass at Leverett Circle. Motorists travelling on this ramp have the choice of continuing through to Storrow Drive or exiting via the existing ramp to Nashua Street.

Improvement to Leverett Circle operations is provided by the addition of a grade separated underpass to accommodate traffic travelling eastbound on Storrow Drive to I-93 and Route 1.

Conformance To Highway Design Criteria.

- o The distance between the Sumner Tunnel on-ramp and the Route 1/Storrow Drive off-ramp is approximately 2,300 feet. This is not considered a problematic weave area.

  The maximum mainline grade and critical length of grade criteria are exceeded in option Z Modified. The profile of the mainlines is constrained at two locations: Causeway Street and the navigational channel in the Charles River. Conceptual bridge designs for the Charles River crossing allow for a 12-foot maximum structural depth. The resulting grade is approximately 5.3 percent, based on a 14.5-foot clearance under Causeway Street and 30-foot clearance over the channel. Although the critical length of grade will be exceeded relative to allowable speed reductions, no climbing lane is provided since vehicles may use adjacent lanes to pass slower moving vehicles.

o Where feasible, horizontal transition curves will be provided for all ramp connections. In option Z Modified, these transition curves are limited to the area north of the Charles River (CANA project area). Due to the existing and future site constraints in the North Station area, transition curves are impractical. Consequently, design speeds for the Storrow Drive ramp connections will be limited to a maximum of 25-mph.

  The configuration of the loop ramp area north of the river meets project criteria. One-lane ramps accommodate a minimum 25-mph design, and two-lane ramps accommodate a minimum 30-mph design. Ramp shoulder widths are consistent with normal design practice. In addition, pavement widening will be provided, where necessary, to obtain adequate sight distance and proper width for passing of stalled vehicles.

o The minimum radius at the interchange "loop" area is approximately 200 feet. Special signing considerations for trucks may be needed to achieve adequate warning. Similar signing may also be necessary at the North Station area where ramp curvature is controlled by existing site constraints. In addition, vertical clearances for these ramp connections is restricted to 14 feet at Leverett Circle and along the existing double-deck ramp structure near the Boston Thermal building.

o Each mainline structure provides 12-foot lanes for through traffic with 4-foot shoulders on the left and 10-foot shoulders on the right.

1.3 TRAFFIC OPERATIONS

The current roadway system serving the Area North of Causeway Street is constrained by vehicular demand that exceeds the existing system's capacity, and by a number of inadequate entry and exit points from the Central Artery. Future growth in traffic volume is expected to place even greater demands on this portion of the network. The options considered for this subarea have been designed to improve the connections between roadways, increase roadway capacities, and provide a greater distance between decision points and entrances and exits to I-93. All of these improvements will both enhance traffic operations and increase the safety of the roadways.

For the purposes of this section, comparisons were made of the relative traffic flow operations that are expected to result with each of the options in place. The criteria which were used to make these comparisons include the quality of traffic flow (expressed as level of service) for weave and merge sections on the mainline and at surface intersections, vehicular speeds on the mainline and the Leverett Circle connector, queue length, number of vehicle miles and vehicle hours travelled (VMT and VHT), and relative traffic safety. The mainline operations analysis covers conditions at weave sections. (A weaving section on a limited-access highway is defined as a length of highway between an on-ramp and an off-ramp where traffic streams must cross by changing lanes. Also of concern is the operation of ramp merges which provide the connection between two highway facilities.)

This section also discusses pedestrian/bicycle operations affected by the options.

1.3.1 Method Of Analysis

The methodologies used in the analysis of options are similar to the procedures used in Part I of this SEIS/R. For the computation of roadway capacities, the 1985 Highway Capacity Manual (HCM), (Highway Capacity Manual, Transportation Research Board Special Report 209, 1985) procedures have been used for analyzing highway link sections. The standard measure of traffic operating conditions at these locations is level of service (LOS). LOS descriptors indicate the overall operating conditions confronting the motorist, and incorporate traffic stream densities, flow interruptions, and travel speed, among several factors.

For signalized intersection analysis, the planning analysis criteria of the HCM were used. All four options were evaluated in a consistent manner, and critical movement sums for key intersections were prepared. (Critical movement sums are the total volume of the two pairs of heaviest crossing traffic movements in the intersection; for example, northbound with opposing left turns plus eastbound with opposing left turns. For the purposes of this report, critical movement sums which have differences no greater than 50 vehicles per hour were considered to be approximately equal.)

As was the case with the earlier traffic analyses in Part I, the determination of vehicular trip assignments, route travel time, VMT, and VHT was achieved via the TRANPLAN traffic modeling program. The data base for TRANPLAN analyses was a variety of network characteristics (e.g., volume to capacity ratios, travel time, and option routes) which allow the program to select the path with the fewest delays throughout the given network based on minimum travel time, resulting in a full network vehicular trip assignment. Where appropriate, travel times were then modified from the TRANPLAN runs based on weaving speeds and/or queue speeds on the portions of the mainline that were analyzed. The formulation of the TRANPLAN assignments, travel times, and VMT/VHT results for this study phase differs from the work prepared for Part I in that the volumes used for this analysis are raw assignment volumes.

The measure of queue length was determined via a modified PC-based analysis that incorporated volume, roadway geometrics, and roadway length. Basically, the analysis indicates that a queue is present when forecasted link volume to capacity ratios (V/C ratios) exceed 1.00. For this work, queuing measures were based on peak 1-hour counts, whereas in the SEIS/R (Part I) queuing measures were based on volume counts over 3 hours during peak periods.

Because the functioning of the intersection of Causeway Street and Surface Artery is of particular concern, a detailed analysis of this intersection was performed using the PASSER-III-88 traffic engineering software package. This analysis evaluated multiple signalization schemes and multiple cycle lengths for each of the examined options for the AM and PM peak hour. Finally, a qualitative assessment of traffic safety was performed with

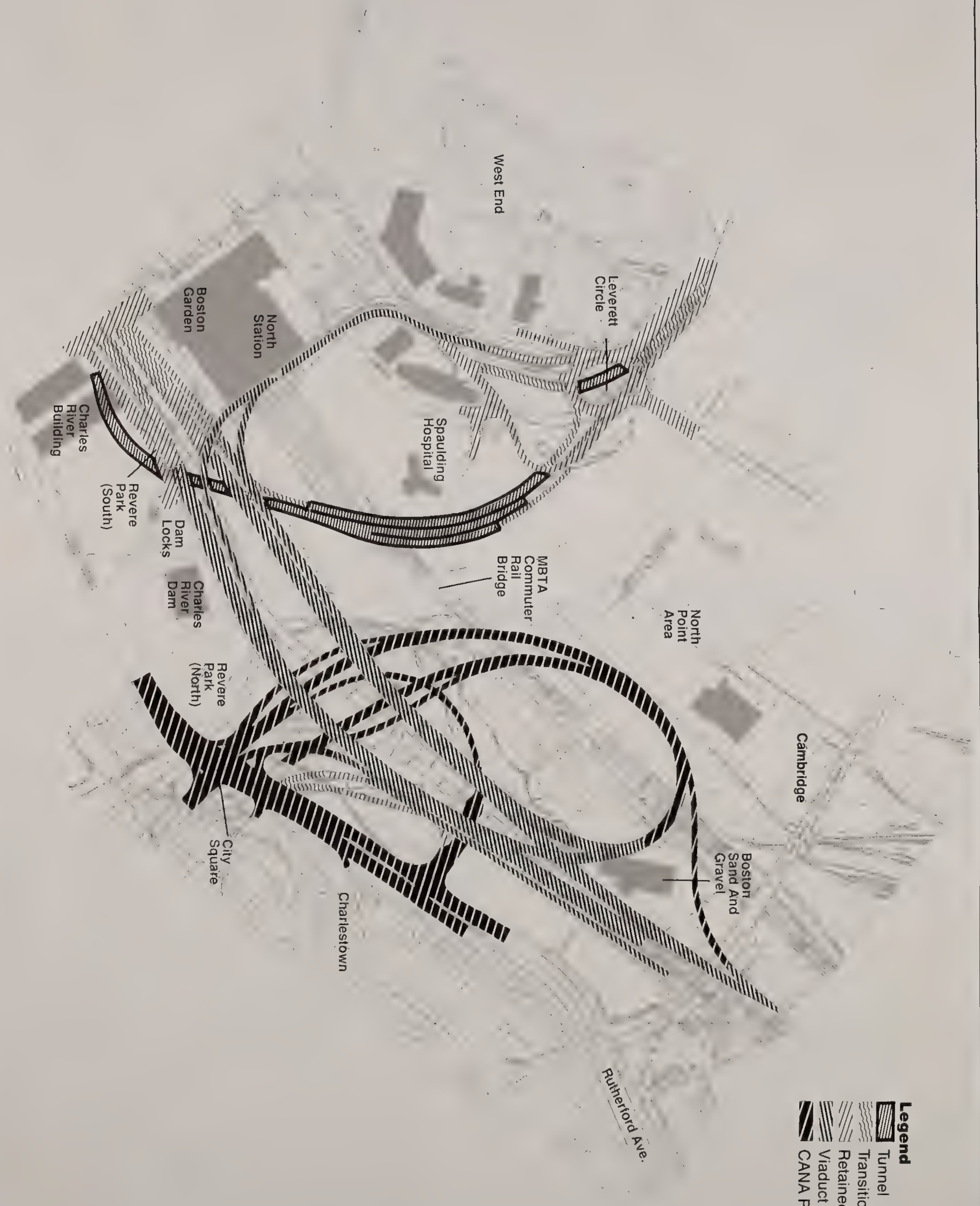


FIGURE
1.3

Option 5A Modified

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

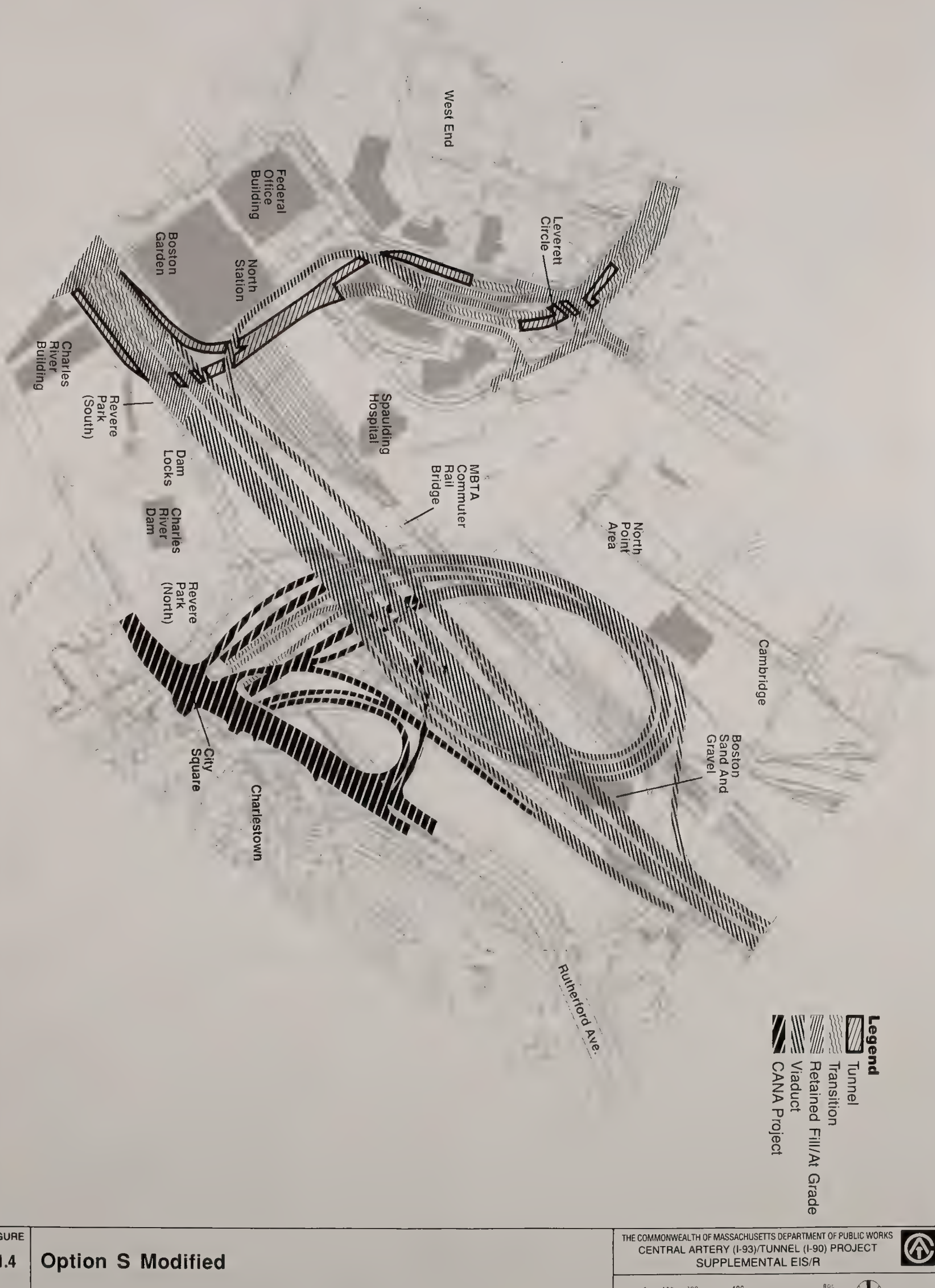


FIGURE
1.4

Option S Modified

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 100 200 400 800
FEET

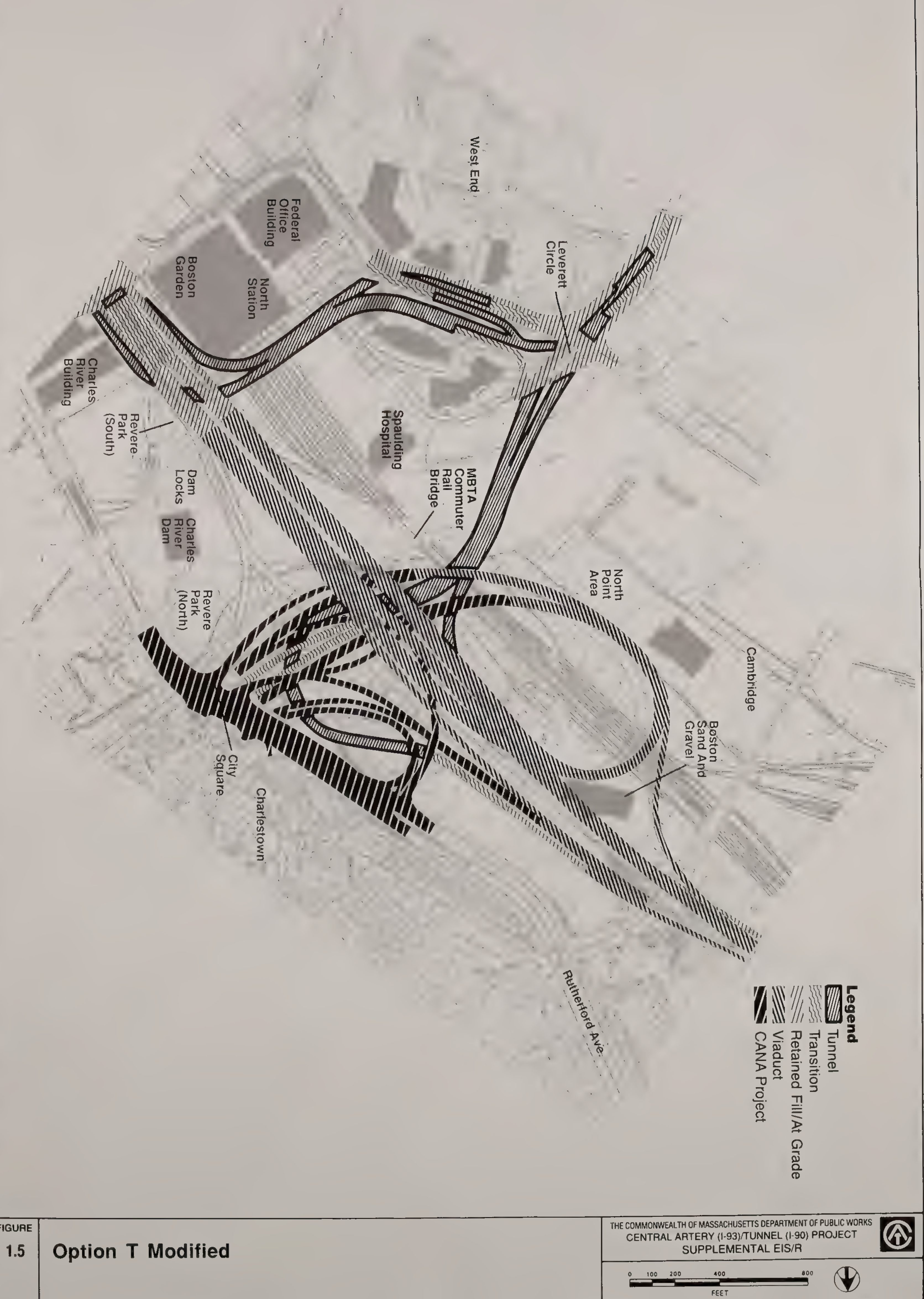


FIGURE 1.5

Option T Modified

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 100 200 400 800
FEET

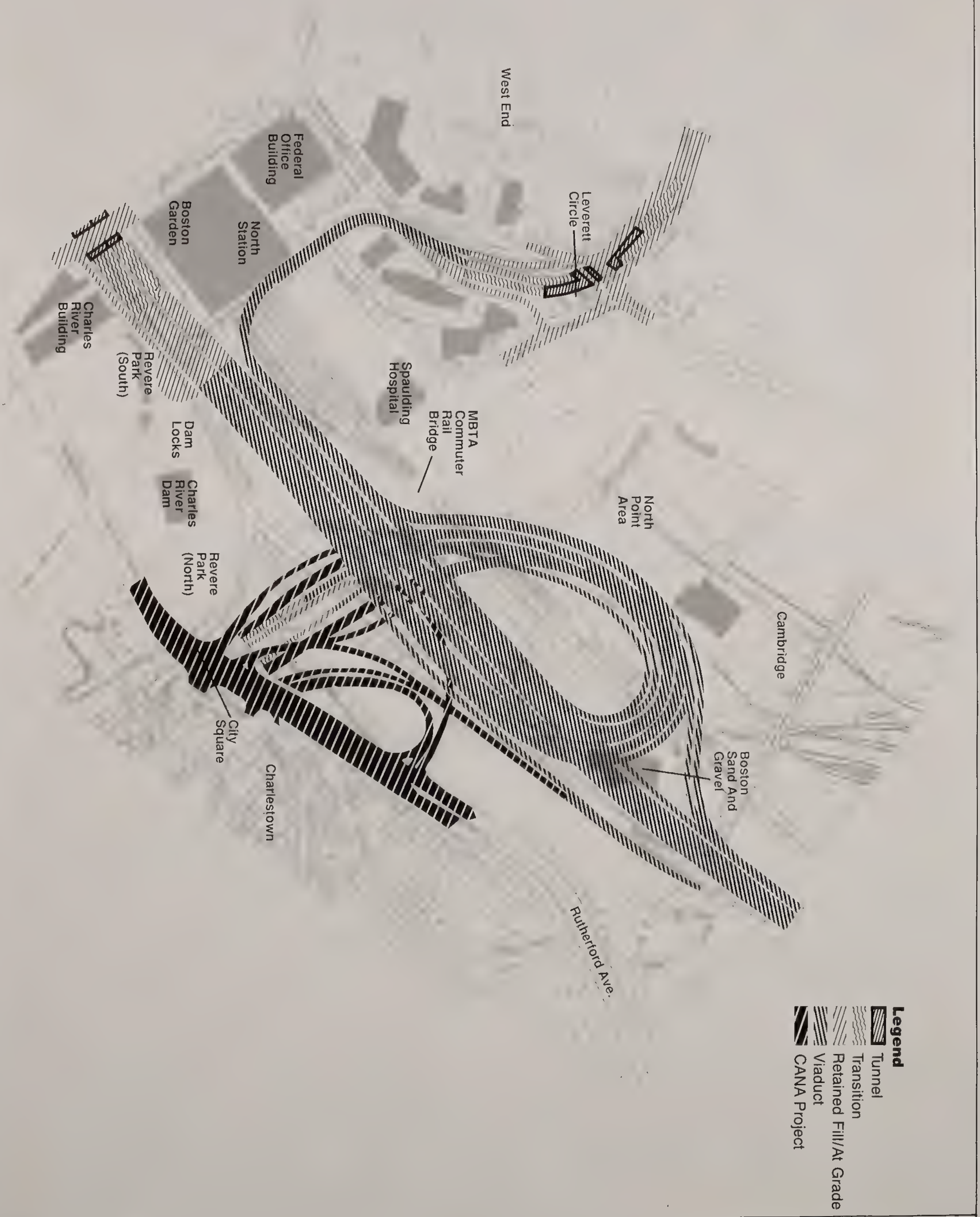


FIGURE
1.6

Option Z Modified/Proposed Action

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

attention to VMT, VHT, the number of weaving sections, ramp merges and diverges, the number of travel lanes provided on mainline and connecting roads, and the length of weaving sections. The vehicular assignments developed from the TRANPLAN program were compared on a screenline basis with Z Modified's network established for Part I and were found to be within a few percentage points of those results. These assignments provide a basis for comparing the options.

The text below describes the operations of each option. The detailed traffic analyses prepared for the study are presented in the figures and tables which follow the written presentation and two summary tables. The detailed information which is presented includes the following:

Figures 1.7 - 1.10: Peak Hour Volumes and Weave Analysis for Each Option

Tables 1.2 Summary of Advantages and Disadvantages of the Options

1.3 Traffic Operations Summary

1.4 Weaving Section Level of Service Summaries

1.5 Highway Ramp Junction Operations - Mainline Volume at Merge

1.6 Summary of Intersection Operations

1.7 Peak Hour Operations at the Intersection of Causeway Street And Surface Artery

1.8 Estimated Peak Hour Travel Times and Speeds on Mainline

1.9 Estimated Peak Hour Travel Times and Speeds on Leverett Circle/Storrow Drive Connector

1.10 Estimated Queues and Queue Speeds

1.11 Comparison of VHT and VMT Measures (Entire Project Study Area)

1.12 Comparison of VHT and VMT Measures (Downtown and Area North of Causeway Street Districts)

Traffic operations for each option are discussed for the following key issues:

- Weaving operations
- Signalized intersection operations
- Travel speed and travel time
- Queue analysis
- Vehicle hours travelled (VHT) and vehicle miles travelled (VMT)
- Generic safety issues

1.3.2 Option 5A Modified

Weaving And Merging Operations. Option 5A Modified relies on mainline weaving sections for access and egress to intersecting roadways (rather than the separate connecting roadways found more often in the other options). For this reason, 5A Modified would encourage a greater degree of lane changing maneuvers with heavy traffic flows which would result in constrained conditions at four of the option's five weaving sections. As shown in Table 1.4, peak hourly travel demand on both the northbound weaving section, and on the southbound weaving section between the Route 1 on-ramp and the Leverett Circle/Causeway Street off-ramp is forecasted to be at or above capacity with travel speeds ranging from 21 to 34 mph. The critical weave from the Sumner Tunnel to Storrow Drive would be the worst of the inadequate weaves in 5A Modified, with the lowest speeds of any option. The southbound weaving section between the Leverett Circle on-ramp and the Callahan Tunnel off-ramp would flow freely with peak hourly travel speeds ranging from 44 to 53 mph, with operating conditions in the LOS C and LOS D range; this weave operates acceptably because the connector tunnel is located a sufficient distance north of the Callahan Tunnel, resulting however, in impacts to the Charles River. This option would not contain any weaving sections on the Leverett Connector/CANA ramps.

Of this option's two ramp merges with I-93 (Table 1-5), the northbound one will accommodate peak hourly volume reasonably well while the other (to southbound I-93) would operate at breakdown conditions during peak periods. This option would not contain any adverse ramp merges on the Leverett Connector/CANA ramps.

Signalized Intersection Operations. At the signalized intersections (Table 1.6), 5A Modified shows the worst traffic flow characteristics of the four options. Only 18 of 30 instances would have AM and PM peak hour critical movement sums under or near the probable capacity of the intersections. In only five instances (i.e., intersections at AM or PM) would critical movement sums be equal to or less than those of the other options (within modelling accuracy of 50 cars per hour).

Travel Speed And Travel Time. In general, 5A Modified would have the slowest mainline travel speeds of all the options. (See Table 1.8.) Over the course of the southbound mainline analyzed (between the Route 1/City Square off-ramp and the New Chardon Street off-ramp), travel speeds would be 15 mph and 17 mph during the AM and PM peak hours, respectively. On the northbound mainline portion analyzed (between the Sumner Tunnel on-ramp and the Route 1/City Square on-ramp), the PM travel speed of 14 mph would be the slowest of all the options, while the AM peak hour speed of 23 mph would be the second lowest. 5A Modified's slow speeds can be traced to queues caused by heavy vehicular demands that would result from the numerous weaving sections associated with the option.

An analysis of travel times was also completed for the Leverett Circle connector, linking the Circle with the mainline. (See Table 1.9.) Morning peak hourly travel time from Storrow Drive to the Artery would be the shortest of the options while its afternoon peak hourly travel time would be the second shortest (speeds of 26 mph and 17 mph, respectively). This is because the Leverett Connector ramp would enter I-93 just downstream of a significant bottleneck. The connector's travel time from the northbound Artery in the morning would be the longest of the four options while its afternoon peak hourly travel time would be the second longest (both are travelled at 12 mph, the slowest speed of all the options).

Queue Analysis. Queues are predicted for each direction of travel during each peak hour on the I-93 mainline and on the ramps between the Central Artery (south of the Charles River) and Storrow Drive. Mainline queue lengths would range from over 2,000 feet (southbound AM) to nearly 2 miles (combined length of AM southbound queues). Ramp queues would range from 700 feet to 4,400 feet.

VHT And VMT. This option would have the greatest number of VHT accumulated by motorists for the entire project study area, as well as in the Area North of Causeway Street and downtown districts. Option 5A Modified would also generate the second highest number of VMT projectwide. (See Tables 1.11 and 1.12.)

Safety Issues. With respect to traffic safety concerns, factors that are unfavorable to this scheme include a lefthand mainline exit ramp at the top of a 5.3-percent upgrade, a very heavy short weaving section on the mainline, and a relatively high VMT total.

1.3.3 Option S Modified

Weaving And Merging Operations. The peak hourly mainline speeds of S Modified (Table 1.4) would be among the slowest of the four options. On three mainline weaving sections, they will measure 29 mph or less, with traffic conditions operating at congested levels during all peak hours. This can be traced to the fact that these weaving sections are very short in length, forcing concentrated lane changing maneuvers to be made among heavy volumes of traffic. The weaving section within S Modified's CANA ramp connection (between the I-93 northbound on-ramp and Route 1/City Square off-ramp) would operate under extremely congested conditions in the PM peak hour and uncongested but constrained (LOS E) conditions during the AM peak hour.

Ramp merges to the mainline in S Modified (Table 1.5) are expected to be congested in the peak direction during the peak hour. The CANA ramp merge from the City Square on-ramp with the Route 1 ramp to I-93 southbound would be congested in both peak hours. The other CANA ramp merge, between the ramp from Causeway Street and the I-93 southbound off-ramp to the Tobin Bridge, would operate at satisfactory levels (LOS C).

Signalized Intersection Operations. The quality of traffic flow at surface intersections under the S Modified scheme would be second best among the four options. (See Table 1.6.) In 20 of 30 AM and PM peak hour instances, critical movement sums would be under or near the probable capacity levels. In 16 instances (i.e., intersections at AM or PM) critical movement sums would be equal or less than those of the other alternatives (within modeling accuracy of 50 cars per hour.)

Travel Speed And Travel Time. S Modified's mainline travel times are among the longest of all of the options. (See Table 1.8.) For the northbound mainline in the AM peak hour, S Modified represents the slowest travel speeds of all the options (17 mph). During the PM peak hour, the northbound mainline travel speed (16 mph) is the second slowest. During the AM peak period on the southbound mainline, S Modified would generate the second slowest speed of all the options (16 mph). These slow speeds are the result of long queues that build from weaving sections which were all found to operate at constrained levels under the weaving analysis described above.

Leverett Circle connector travel speeds (Table 1.9), in both directions and during both peak hour periods, would be the second worst of all of the options (ranging between 13 mph and 14 mph from I-93 northbound and between 14 and 17 mph from I-93 southbound). Consistent with this, its morning and afternoon east- to southbound peak period travel times would be the longest or second longest of the four options. Its north- to westbound travel times are expected to be the second longest in both peak hours.

Queue Analysis. Queues (Table 1.10) are predicted for each direction of travel during each peak hour on the I-93 mainline and on the ramps between the Central Artery (south of the Charles River) and Storrow Drive. Mainline queue lengths would range from 370 feet in the PM southbound case to a combined queue length of 1.5 mile in the AM southbound case. Ramp queue lengths would range from 630 feet (at Nashua Street, AM) feet to 3,600 feet (on the Storrow Drive approach to Leverett Circle, PM).

VHT And VMT. The configuration of S Modified includes many ramps, which, while not always providing as direct a connection as the other options, has the effect of spreading traffic flow out over a larger area. This will result in less congestion and thus the lowest number of VHT of all the options, and the second lowest number of VMT, projectwide.

Safety Issues. With respect to traffic safety concerns, factors that are unfavorable to S Modified include a great number of ramp connections and two short mainline weave sections. Favorable attributes include low VHT and VMT rates.

1.3.4 Option T Modified

Weaving And Merging Operations. There are a relatively large number of mainline weaving sections associated with this option. (See Table 1.4) Two of the mainline weave sections are considered unacceptably short in length (i.e., under 1,000 feet). These weaves replace ramps that directly connect major roadways in other options and result in a greater degree of lane changing maneuvers by heavy traffic flows. Peak hourly travel demand in excess of capacity is forecasted at three of the four mainline weaving sections with travel speeds between 22 mph and 29 mph, all LOS F conditions. At the uncongested weave section on I-93 southbound between the Route 1 on-ramp and the Causeway Street off-ramp, travel speeds would range between 41 mph and 42 mph, with operating conditions in the LOS D and LOS E range.

Two CANA ramp weave sections occur in T Modified. The weave between the Leverett Circle and Merrimac Street on-ramps and the I-93 northbound off-ramp would be congested during the PM peak hour and takes place in tunnel. The weave of the I-93 northbound and I-93 southbound off-ramps with the ramps to the Tobin bridge and City Square would be uncongested.

Merges are shown in Table 1.5. On the single mainline ramp merge associated with T Modified (the Leverett Circle on-ramp to I-93 northbound), the on-ramp and the right lane would tend to be congested during both peak hours, while the left lane would tend to operate without congestion during both peak periods. T Modified would not contain any merges on the CANA ramps.

Signalized Intersections Operations. The analysis of traffic flow operations at surface intersections (Table 1.6) indicated that only 18 of 30 instances would have AM and PM peak hour critical movement sums under or near probable capacity levels. In 13 instances (i.e., intersections at AM or PM) the critical movement sums would be equal to or less than those of the other alternatives (within the modelling accuracy of 50 cars per hour). This is the worst percentage of the options developed after 5A Modified.

Travel Speed And Travel Time. T Modified generally would result in relatively high travel speeds over the course of the analyzed mainline sections. (See Table 1.8.) In the PM peak hour, the calculated travel speed on the northbound mainline for T Modified would be 19 mph, which would result in the second shortest travel time of all of the options. Similarly, T Modified's speed of 36 mph during the PM peak hour on the southbound mainline would be, together with Z Modified, the highest speed found. Travel times in the AM peak hour would not be as fast. On the southbound mainline in the AM hour, T Modified's speed of 15 mph would be, together with 5A Modified, the lowest of the four options. On the northbound mainline, the resulting speed of 25 mph would be the second highest. While T Modified was found to have poor operations at weave sections, reasons for the relatively fast northbound speeds could be related to the fact that the mainline configuration has only one ramp connection.

On the Leverett Circle connector (Table 1.9), travel times to the southbound Artery would be the longest of all of the options during both peak hour periods (performing slightly worse than S Modified); travel speeds would be 17 mph and 13 mph in the AM and PM peaks, respectively. In contrast, travel from the northbound Artery would represent the second highest speed of the four of the schemes (23 mph AM and 17 mph PM). Its peak hourly travel times in this direction would be the lowest of all options.

Queue Analysis. Queues (Table 1.10) are predicted for each direction of travel during each peak hour on the I-93 mainline and on the ramps between the Central Artery (south of the Charles River) and Storrow Drive. Mainline queue lengths would range from 490 feet (PM southbound) to 1.75 miles (AM southbound). Leverett Connector ramp queues toward I-93 southbound would range from 700 feet (AM) to a combined length of one mile (PM).

VHT And VMT. Principally because of the Route 1 river crossing and shortened connecting roadways between Route 1 and I-93, T Modified would generate the lowest VMT of all of the alternatives over the entire study area as well as in the Area North of Causeway Street and the downtown districts. The low VMT measure is a contributing factor in the relatively low VHT characteristics associated with this scheme. (See Tables 1.11 and 1.12.)

Safety Issues. With respect to traffic safety concerns, factors that are unfavorable to T Modified include a large number of weave sections (particularly on the mainline, where the length of two of these sections is under 1,000 feet) and a substantial length of roadway in tunnels. Favorable attributes include relatively low VHT and VMT rates.

1.3.5 Z Modified

Weaving And Operations. Peak hourly travel demand on the I-93 southbound weaving section is forecasted to be at or over capacity, with morning and afternoon peak hourly travel speeds of 27 mph and 30 mph, respectively. At the three CANA ramp weave sections which occur in this option, conditions would be uncongested but constrained (LOS E) with speeds ranging between 27 mph and 40 mph, except for the AM weave to the Nashua Street ramp, which would be congested.

Table 1.5 shows merge conditions. Peak hourly congestion would be expected at the merge between I-93 southbound and the Leverett Circle on-ramp. The other mainline ramp associated with this scheme (the on-ramp from Route 1/City Square to I-93 northbound) would have PM peak hour conditions of LOS E (mainline) and F (first lane), and AM peak hour volume conditions of LOS C (mainline) and D (first lane). At the single CANA ramp merge associated with Z Modified, mainline operating conditions would be congested during the AM peak hour, but uncongested (LOS E) during the PM peak hour.

Signalized Intersection Operations. Z Modified would represent the best traffic flow characteristics at surface intersections of the four alternatives. (See Table 1.6.) In 22 of 30 instances, AM and PM peak hour critical movement sums would be under or near probable capacity levels. In 25 of 30 instances (i.e., intersections at AM or PM) critical movement sums would be equal to or less than those of the other alternatives (within the modelling accuracy of 50 cars per hour).

Z Modified alone among the options does not have a "diamond intersection" configuration of closely spaced signalized intersections on Causeway Street, accommodating a heavy left-turn volume. (Under the other options, ramps to and from the north cannot pass under Causeway Street because of conflict with the Leverett Connector ramps.) In the case of Z Modified, vehicles desiring access to or egress from the North Station area would be routed through better designed intersections. This will result in favorable traffic operations for morning and afternoon peak hourly flow and also for Boston Garden events where a large concentrated traffic volume is generated, usually during the off peak period. Z Modified represents an improvement over that of the other options, in terms of both surface street quality of flow and exit ramp queuing.

Travel Speed And Travel Time. As in the other options, the segment of I-93 northbound between the Sumner/Callahan Tunnel ramps and the north bank of the Charles River would experience peak hour congestion, especially during the afternoon peak as a result of the 5.3 percent upgrade. However, Z Modified was found to consistently generate the fastest travel speeds along both the north- and southbound mainlines during both peak hours. (See Table 1.8.) In three of the four total travel time runs analyzed, this option would have the fastest travel speeds, and in the fourth case Z Modified had a speed nearly equal to the fastest. These rapid travel speeds are the result of the limited number of weaving sections associated with this scheme (which diminishes opportunities for the buildup of queues) and the relatively smooth traffic flow found at adjacent intersections.

Similarly, on the Leverett Circle connector (Table 1.9), Z Modified would consistently have the fastest travel speeds in both directions. From the northbound Artery, peak hour speeds would be 25 mph AM and 27 mph PM. In the direction toward the southbound Artery, they would be 28 mph AM and 33 mph PM. For the northbound to westbound movement its morning and afternoon peak hourly travel times would be the second shortest after T Modified. For the east- and southbound movement, its corresponding travel times would be the second shortest and shortest, respectively.

Queue Analysis. Queues are predicted for each direction of travel during each peak hour on the I-93 mainline and on the ramps between the Central Artery (south of the Charles River) and Storrow Drive. Mainline queue lengths would range from 2,650 feet (at the Sumner Tunnel on-ramp, PM) to 4,030 feet (AM southbound). Ramp queues would be approximately 2,200 to 2,300 feet.

VHT And VMT. Primarily because of the large loop route from I-93 northbound to Leverett Circle and the fact that this scheme has the greatest number of ramps, Z Modified would result in the highest VMT and the second highest VHT of all the schemes. The loop has been included to increase weaving distances and thus enhance operations and safety.

Safety Issues. With respect to traffic safety concerns, factors that are unfavorable to Z Modified include relatively high VHT and VMT rates and a large number of ramp connections. Factors that are favorable attributes are the long length of the ramp connections, the small number of mainline weave sections, and the absence of roadway in tunnels (except the Leverett Circle underpass).

1.3.6 Comparison Of Traffic Operations And Impacts

Each of the four options presents a different solution for access between Leverett Circle/Storrow Drive, I-93, and Route 1 for the Area North of Causeway Street. All of these options address the critical weave condition between the Sumner/Callahan on- and off-ramps and the on- and off-ramps to Route 1. However, the critical weave section occurs between the Sumner/Callahan tunnels and Storrow Drive. Only one option (Z Modified) avoids this critical weave section. None of the options is able to eliminate the undesirable weave condition that occurs where two northbound lanes from the I-93 northbound ramp to Route 1 merge with one I-93 southbound off-ramp lane to form three lanes before they split, with one lane going to the North Washington Street bridge in City Square and two lanes entering Route 1 northbound. Significant weaving in this section is expected to result from those vehicles destined for City Square that originate from I-93 northbound. VHT and VMT, which are related to energy use, air quality, and safety differ only marginally among the options.

In order to evaluate the relative merits of the options, a summary of advantages and disadvantages, and an operations summary, have been prepared (see Tables 1.2 and 1.3).

These may be summarized as follows:

5A Modified compares poorly with other options, with three of the mainline weaving sections inadequate in length, and with the lowest peak period mainline travel speeds. The Surface Artery intersection with Causeway Street would be congested, and only 17 percent of signalized surface street intersections would work as well as or better than in other options. The left-hand exit ramp from I-93 at the top of an upgrade would be a safety deficiency, as would the short weaving sections.

S Modified has two major inadequate weave sections (between Leverett Circle and the Summer and Callahan tunnels) and relatively low peak hour travel speeds. The Surface Artery intersection with Causeway Street would be a source of downtown congestion and pedestrian-vehicle conflicts, and only 53 percent of signalized surface street intersections would work as well as or better than in other options. The short weave sections pose safety deficiencies.

T Modified has two major inadequate weave sections between Leverett Circle and the Summer and Callahan tunnels but achieves relatively high peak hour travel speeds elsewhere. The Surface Artery intersection with Causeway Street would be a source of downtown congestion and pedestrian-vehicle conflicts, and only 43 percent of signalized surface street intersections would work as well as or better than in other options (the worst percentage of the options developed after 5A Modified). The short weave sections pose safety deficiencies.

In Z Modified all four major weave sections are of adequate length (including the Leverett Circle/Sumner and Callahan Tunnel movements), and peak hour travel speeds are in general the best of the four options on both mainlines and connectors. Only Z Modified eliminates the Surface Artery intersection with Causeway Street and local on- and off- ramps; (other options cannot relocate these local ramps because of geometric conflicts with their Leverett Circle connectors). In addition, over 80 percent of signalized surface street intersections would work as well as or better than in the other options. Avoidance of short weaving sections eliminates a safety deficiency of the other schemes, although Z Modified's higher total vehicle miles travelled offsets some of this safety improvement. As in the other options northbound congestion would occur in the PM peak hour.

As indicated above, option Z Modified consistently operates favorably with respect to the variables evaluated. While no single option always ranks on top with respect to each criterion, Z Modified emerges as having reasonably good operations in all locations, ranks best among the options for almost all of the key variables, and shows no serious operational deficiencies.

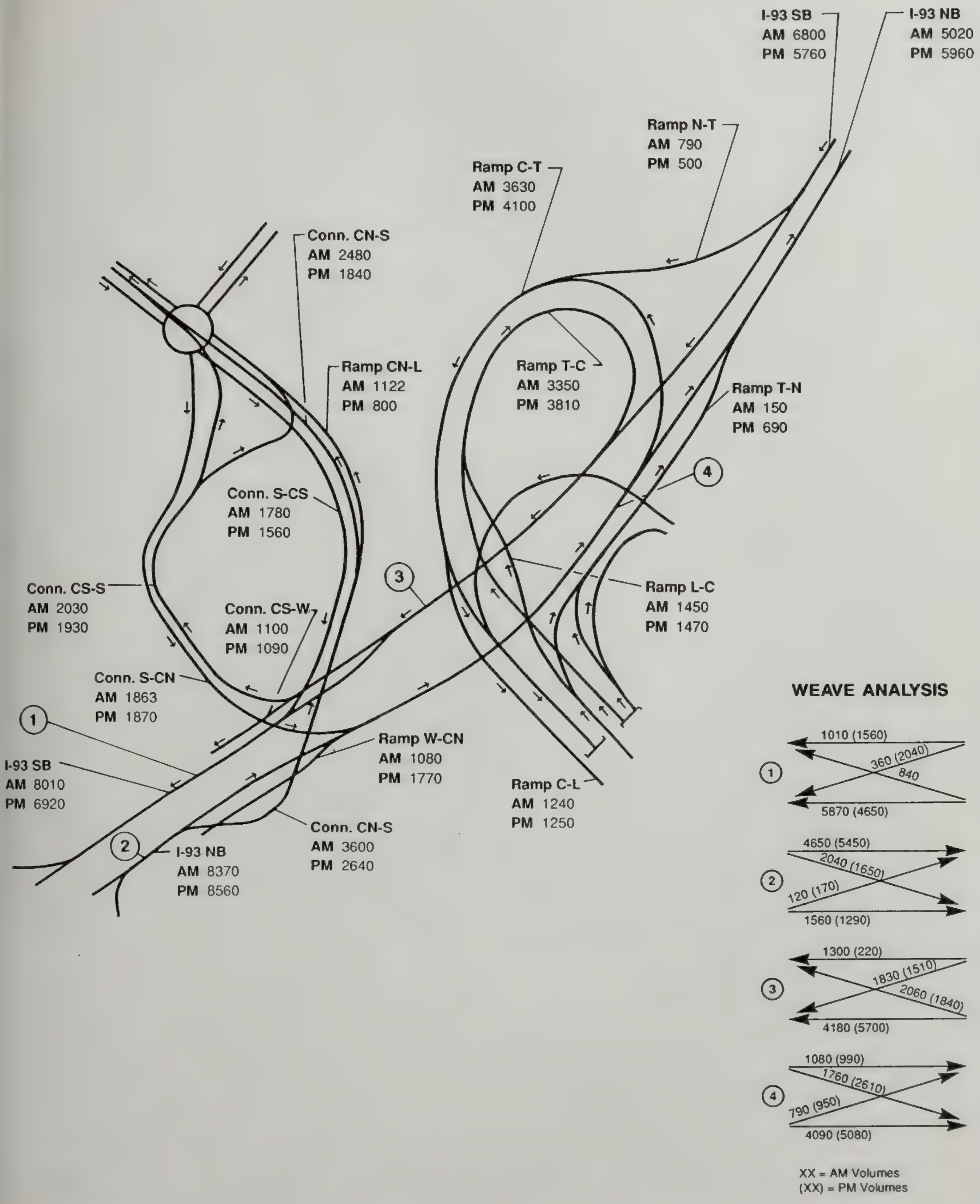
1.3.7 Pedestrian/Bicycle Circulation

The Area North of Causeway Street includes a series of existing and planned pedestrian/bicycle pathways along the north and south banks of the Lower Charles River. When completed, these facilities will form a system of pedestrian and bicycle connections between Cambridge and Charlestown on the north bank of the river; between Charlestown and the North Station area, via the existing walkway over the Charles River dam locks; and between Leverett Circle and the North End on the south bank of the river. (The final link on the south bank would involve air rights development over the commuter railroad tracks.) The impacts on the pedestrian/bicycle system associated with each option are described below.

Most segments of the pedestrian/bicycle circulation system will be disrupted at various times during project construction. These impacts would be of relatively short duration, however. The development of most planned pedestrian/bicycle facilities would be a part of the proposed mitigation program.

Option 5A Modified. An on-ramp from Causeway Street, integral to this alignment, would obstruct the pedestrian connection to Causeway Street and a ventilation building would occupy part of Lovejoy Wharf.

Also on the south side of the Charles, a transition section connecting the southbound Leverett Circle on-ramp with I-93 would conflict with the existing MBTA walkway on the railroad trestle. Farther to the west, the transition section of the northbound Leverett Circle connector would be placed directly along the water's edge on the south bank of the Charles, resulting in a serious conflict with the planned extension of the Charles River Esplanade path system easterly from Leverett Circle.



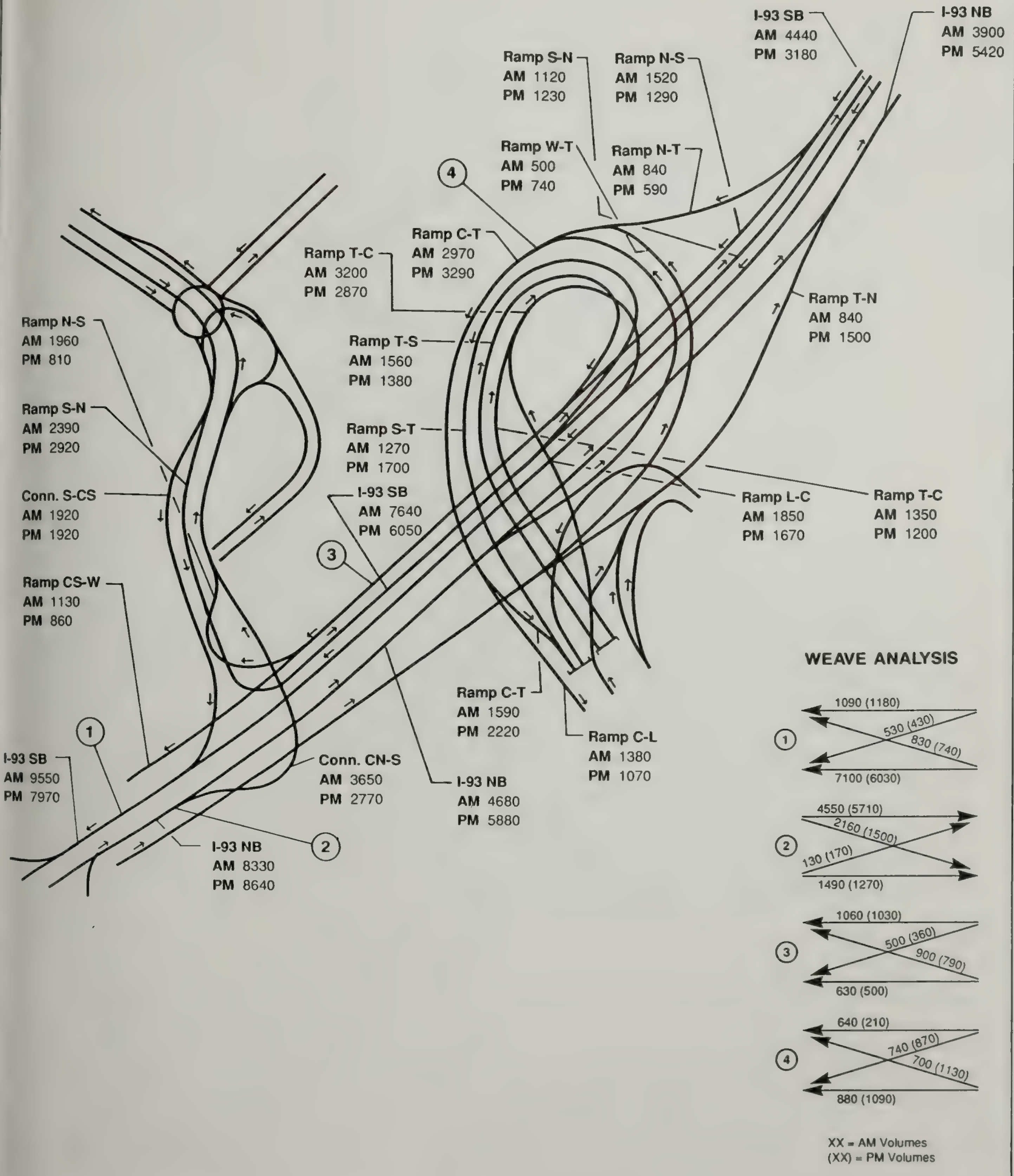
FIGURE

1.7

Option 5A Modified, Peak Hour Volumes And Weave Analysis

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

(Not To Scale)

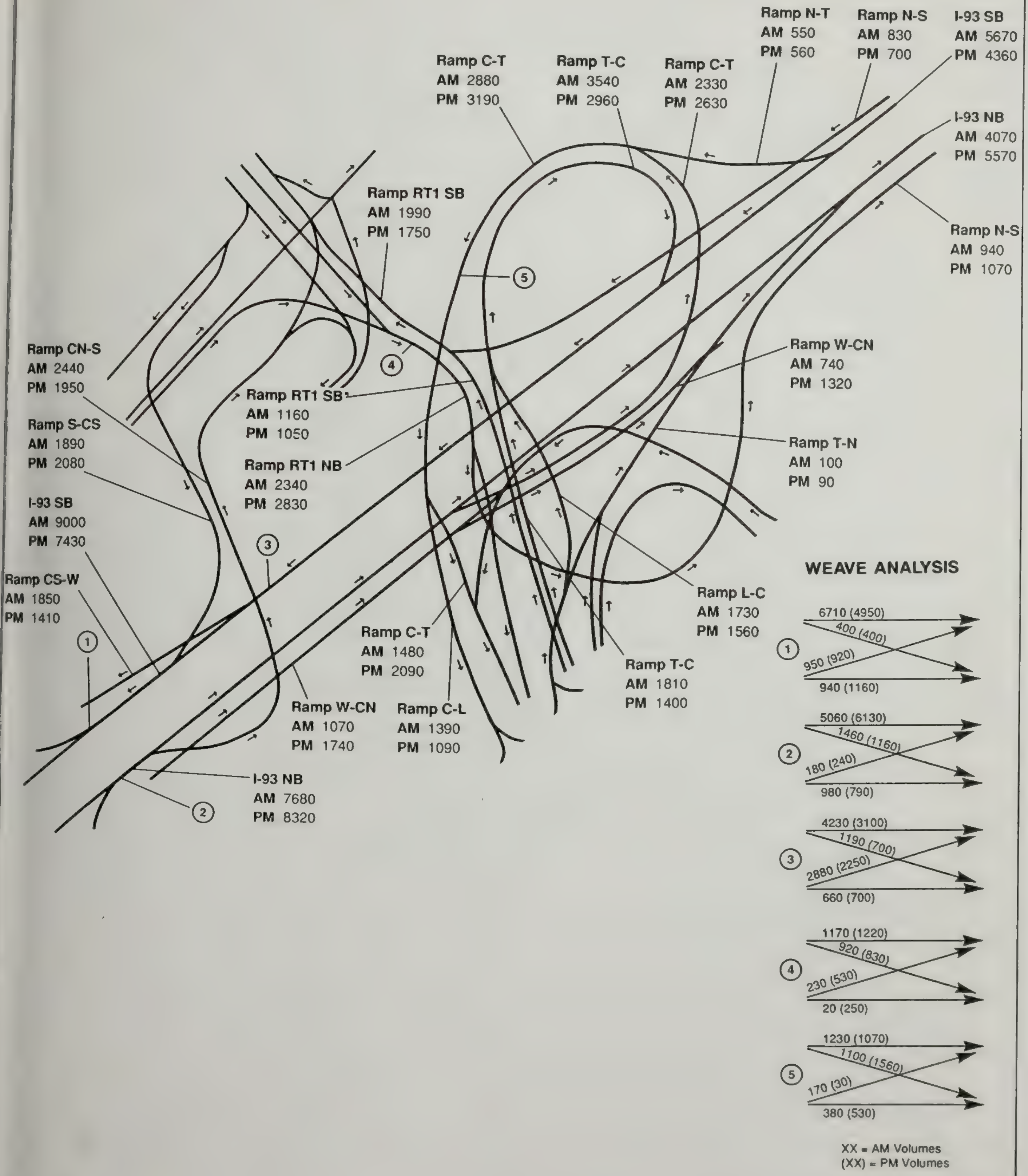


FIGURE

1.8 Option S Modified, Peak Hour Volumes And Weave Analysis

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

(Not To Scale)

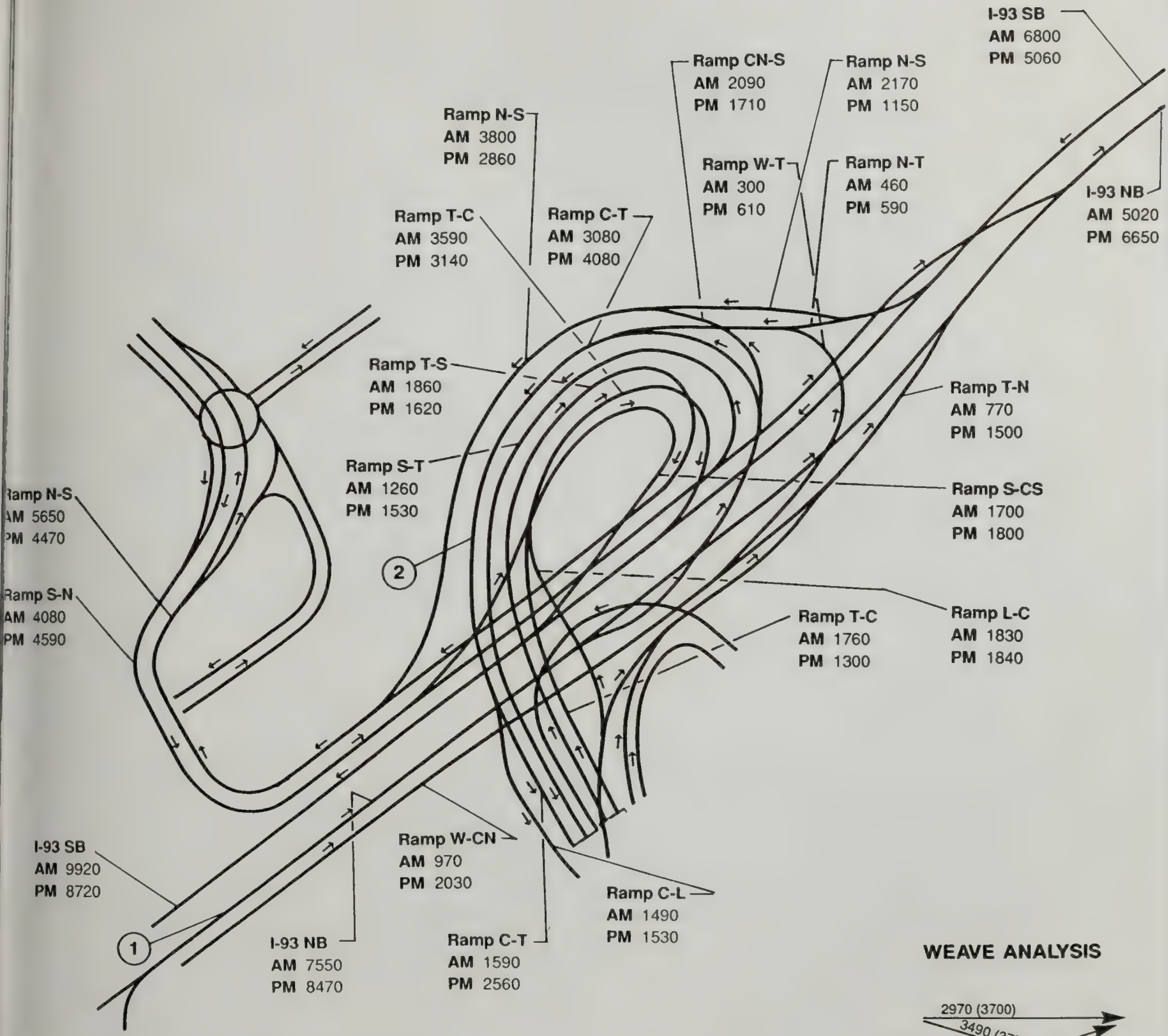


FIGURE

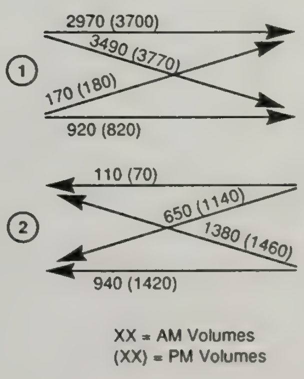
1.9 **Option T Modified, Peak Hour Volumes And Weave Analysis**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

(Not To Scale)



WEAVE ANALYSIS



XX = AM Volumes
(XX) = PM Volumes

FIGURE

1.10

Option Z Modified, Peak Hour Volumes And Weave Analysis

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

(Not To Scale)

Table 1.2

SUMMARY OF ADVANTAGES AND DISADVANTAGES OF THE OPTIONS

5A Modified

Advantages:

- Adequate southbound weaving section from Leverett Circle entrance to Callahan Tunnel exit

Disadvantages:

- Congested weaving sections between Route 1 ramps and Leverett Circle ramps, especially southbound, and from Sumner Tunnel northbound to Storrow Drive
- Lowest overall I-93 peak period travel speeds
- Causeway Street intersection congestion and pedestrian conflict
- Safety deficiency - left-hand exit ramp from I-93 at the top of a 5.3-percent upgrade
- Surface streets - 17 percent of signalized intersection scenarios analyzed would be as good as or better than those of other options

S Modified

Advantages:

- Low VHT and VMT

Disadvantages:

- Short, sometimes congested weaving sections between Leverett Circle ramps and Sumner/Callahan Tunnel ramps
- Relatively low peak period travel speeds
- Causeway Street intersection congestion and pedestrian conflict
- Surface streets - 53 percent of the signalized intersection scenarios analyzed would be as good as or better than those of other options
- Safety deficiency - short weaving sections

T Modified

Advantages:

- Lowest VMT; low VHT
- Relatively high peak period travel speeds

Disadvantages:

- Short, sometimes congested weaving sections between Leverett Circle ramps and Sumner/Callahan Tunnel ramps. Undesirable weave in tunnel.
- Causeway Street intersection congestion and pedestrian conflict
- Surface Streets - 43 percent of the signalized intersection scenarios analyzed would be as good as or better than those of other options
- Safety deficiencies - short weaving sections

Table 1.2 (Cont.)

SUMMARY OF ADVANTAGES AND DISADVANTAGES OF THE OPTIONS

Z Modified

Advantages:

- o Long distances between entrance and exit ramps, elimination of weaving sections
- o Avoids Causeway Street intersection congestion and pedestrian conflicts
- o Surface Streets - 83 percent of the signalized intersection instances analyzed would be as good as or better than those of the other options
- o Highest overall travel speeds

Disadvantages:

- o Northbound congestion - afternoon peak hour
- o Highest VMT partially offsets elimination of unsafe weaves

Source: Bechtel/Parsons Brinckerhoff

Table 1.3

TRAFFIC OPERATIONS SUMMARY

	Options			
Affected Area	**5A Modified**	**S Modified**	**T Modified**	**Z Modified**
Percent of signalized intersections functioning better than or equal to those of other options	17 %	47 %	43 %	80 %
Index of mainline[1] speed and time (1 best - 4 worst)	3.56	3	1.94	1.38
Index of connector[1] speed and time (1 best - 4 worst)	2.63	2.88	2.75	1.63
Queue length				
Mainline	2,000' - 2 mi	370' - 1.5 mi	490' - 1.75 mi	2,600' - 4,000'
Ramp	700' - 4,400'	630' - 3,600'	700' - 1.0 mi	2,200' - 2,300'
Number of inadequate mainline weave sections	3	2	2	0
Causeway Street congestion	Severe	Severe	Severe	Good
VMT (entire project area)	5,202,000	5,200,000	5,180,000	5,231,000

---

1. Average rank among four options for travel time and travel speed for AM and PM peak hours for northbound and southbound travel (best time or speed = 1 point; worst time or speed = 4 points) [see Table 1.7 (Mainline) and Table 1.8 (Connectors)]
2. The difference in VMT and VHT among the options for the area covering downtown, the West End, and the Area North of Causeway Street is minor; this indicates that these options would not affect traffic conditions to any great degree beyond the Area North of Causeway Street (see Table 1.12)

Source: Bechtel/Parsons Brinckerhoff

TABLE 1.4

WEAVING SECTION LEVEL OF SERVICE SUMMARIES AREA NORTH OF CAUSEWAY STREET ALTERNATIVES ANALYSIS

	5A Modified Weaving Section Computed Speeds (mph)						S Modified Weaving Section Computed Speeds (mph)						T Modified Weaving Section Computed Speeds (mph)						Z Modified Weaving Section Computed Speeds (mp				
	AM Pk Hr		PM Pk Hr		LOS		AM Pk Hr		PM Pk Hr		LOS		AM Pk Hr		PM Pk Hr		LOS		AM Pk Hr		PM Pk Hr		L
Weave Section	Wv	Non-Wv	Wv	Non-Wv	AM	PM	Wv	Non-Wv	Wv	Non-Wv	AM	PM	Wv	Non-Wv	Wv	Non-Wv	AM	PM	Wv	Non-Wv	Wv	Non-Wv	AM
Highway Links – Northbound																							
Central Artery between:																							
Sumner Tunnel On- And Leverett Circle Off-Ramps (5A, S, T)	21	21	22	22	F	F	22	30	21	21	F	F	22	22	22	22	F	F					
Leverett Circle On- And Route 1 (Tobin Bridge) Off-Ramps (5A)	34	34	*	*	E	F																	
Highway Links – Southbound																							
Central Artery between:																							
Route 1 (Tobin Bridge) On- And Leverett Circle/Causeway Street Off-Ramps (5A)	*	*	*	*	F	F																	
Route 1 (Tobin Bridge) On- And Causeway Street Off-Ramps (T)													34	34	41	42	E	D					
Leverett Circle On- And Callahan Tunnel Off-Ramps	44	51	45	53	D	C	26	26	29	29	F	F	27	27	29	29	F	F					
New Chardon Street On- And Oliver Street Off-Ramps	26	26	29	29	F	F	26	26	28	28	F	F	26	26	27	27	F	F	27	27	30	30	F
Leverett Connector/ CANA Ramp Weaves																							
Route 1 NB: I-93 On To City Square Off							30	45	29	41	E	F	43	50	40	47	D	D	30	40	27	36	E
Route 1 NB: Leverett On To I-93 SB Off																			32	32	30	30	E
Route 1 NB: Merrimac On To I-93 NB Off													36	41	23	28	E	F					
Route 1 SB: I-93 On To Nashua Street Off																			29	29	36	36	F

** Exceeds maximum weaving volume range –> LOS F*

TABLE 1.5

HIGHWAY RAMP JUNCTION OPERATIONS – MAINLINE VOLUME AT MERGE (PCPH) AREA NORTH OF CAUSEWAY STREET ALTERNATIVES ANALYSIS

	5A Modified				S Modified				T Modified				Z Modified			
	Freeway Volume At Merge (pcph)		LOS		Freeway Volume At Merge (pcph)		LOS		Freeway Volume At Merge (pcph)		LOS		Freeway Volume At Merge (pcph)		LOS	
Lation	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
I3 Northbound Merges																
-Ramp From Causeway	8390	10410	F	F												
-Ramp From Route 1/ ity Square	5390	6930	C	E	4320	7120	D	F					4190	5760	C	E
-Ramp From Leverett Circle									5390	7140	C	E				
I3 Southbound Merges																
-Ramp From Leverett Circle													10620	8850	F	F
-Ramp From Route 1/ City Square					8140	6440	F	D								
verett Connectors/CANA amp Merges																
ty Sq. On-Ramp With oute 1 Off-Ramp					3440	3080	E	D								
f-Ramp From Causeway With -93 SB Off-Ramp					1400	1430	C	C								
93 SB Off-Ramp With -93 NB Off-Ramp													3990	3000	E	D
93 SB Off-Ramp With Route 1 NB	3900	4410	F	F												

HIGHWAY RAMP JUNCTION OPERATIONS – LANE 1 VOLUME AT MERGE (PCPH) AREA NORTH OF CAUSEWAY STREET ALTERNATIVES ANALYSIS

	5A Modified				S Modified				T Modified				Z Modified			
	Lane 1 Merge Volume (PCPH)		LOS		Lane 1 Merge Volume (PCPH)		LOS		Lane 1 Merge Volume (PCPH)		LOS		Lane 1 Merge Volume (PCPH)		LOS	
cation	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
93 Northbound Merges																
n-Ramp From Causeway	>2000	>2000	F	F												
n-Ramp From Route 1/ City Square	960	1520	B	D	1080	>2000	C	F					560	>2000	D	F
n-Ramp From Leverett Circle									>2000	>2000	F	F				
-93 Southbound Merges																
n-Ramp From Leverett Circle													>2000	>2000	F	F
n-Ramp From Route 1/ City Square					>2000	1910	F	E								
everett Connectors/CANA Ramp Merges																
ity Sq. On-Ramp With Route 1 Off-Ramp					>2000	>2000	F	F								
ff-Ramp From Causeway With I-93 SB Off-Ramp					1440	1430	C	C								
-93 SB Off-Ramp With I-93 NB Off-Ramp													>2000	1850	F	E
-93 SB Off-Ramp With Route 1 NB	2000	>2000	E	F												

TABLE 1.6

SUMMARY OF INTERSECTION OPERATIONS AREA NORTH OF CAUSEWAY STREET ALTERNATIVES ANALYSIS

	5A Modified				S Modified				T Modified				Z Modified			
	AM		PM		AM		PM		AM		PM		AM		PM	
Intersection	Sum Of Crit. Vol.	Cap. Status	Sum Of Crit. Vol.	Cap. Status	Sum Of Crit. Vol.	Cap. Status	Sum Of Crit. Vol.	Cap. Status	Sum Of Crit. Vol.	Cap. Status	Sum Of Crit. Vol.	Cap. Status	Sum Of Crit. Vol.	Cap. Status	Sum Of Crit. Vol.	Cap. Statu
City Square	1520	over	1580	over	1480	over	1350	near	1440	over	1340	near	1470	over	1300	nea
Leverett Circle	1600	over	1430	over	1560	over	1790	over	1570	over	1560	over	1430	over	1270	nea
Causeway/Lomasney/ Staniford/Merrimac	1340	near	1160	under	1250	near	1070	under	1480	over	1370	near	1250	near	910	unde
Causeway/Surface Artery SB	1690	over	1310	near	1560	over	1120	under	1850	over	1420	over	1250	near	1150	unde
New Chardon/Surface Artery	1320	near	1200	under	1250	near	1190	under	1380	near	1180	under	1150	under	1240	nea
New Sudbury/Surface Artery	590	under	820	under	590	under	810	under	580	under	710	under	570	under	740	unde
State/Surface Artery	1190	under	490	under	1110	under	490	under	1170	under	520	under	1120	under	730	unde
North/Surface Artery	1360	near	1150	under	1260	near	1120	under	1300	near	1030	under	1080	under	1120	unde
Keany Square	1780	over	2010	over	1440	over	1640	over	1320	near	1630	over	1410	over	1630	ove
Congress/New Chardon	1760	over	1340	near	1610	over	1240	near	1780	over	1230	near	1575	over	1170	unde
Congress/New Sudbury	1170	under	1290	near	1080	under	1180	under	1100	under	1150	under	1060	under	1260	nea
Oliver/Purchase	1450	over	1400	near	1520	over	1380	near	1510	over	1320	near	1435	over	1240	nea
Valenti Way/Surface Artery	1460	over	1210	near	1390	near	1270	near	1430	over	1210	near	1300	near	1020	unde
O'Brien Hwy/Gilmore Bridge	2100	over	2140	over	2060	over	2070	over	2070	over	2120	over	2060	over	2050	ove
Causeway/Surface Artery NB/ On-Ramp To I-93 NB	1180	under	1370	near	1120	under	1290	near	1160	under	1340	near	NA		NA	

Key:

Maximum Sum Of Critical Volumes	Capacity Level
0 to 1200	under
1201 to 1400	near
> 1400	over

Table 1.7

PEAK HOUR TRAFFIC OPERATIONS AT THE INTERSECTION OF CAUSEWAY STREET AND SURFACE ARTERY

	5A Mod		S Mod		T Mod		Z Mod	
Approach	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
AVERAGE APPROACH DELAY (Seconds per vehicle)								
Causeway Street EB	253	62	191	38	194	71	10	12
Causeway Street WB	220	225	137	504	90	188	23	16
Surface Artery NB	232	216	140	494	80	174	N/A	N/A
I-93 SB Off-Ramp	220	66	181	43	164	48	N/A	N/A
VOLUME-TO-CAPACITY RATIO								
Causeway Street EB	1.24	0.96	1.17	0.81	1.17	0.93	0.60	0.71
Causeway Street WB	1.23	1.22	1.12	1.45	1.02	1.18	0.60/0.99	0.71/0.92
Surface Artery NB	1.23	1.22	1.12	1.45	1.03	1.18	N/A	N/A
I-93 SB Off-Ramp	1.25	0.96	1.18	0.81	1.17	0.93	N/A	N/A
LEVEL OF SERVICE								
Causeway Street EB	F	E	F	D	F	E	B	B
Causeway Street WB	F	F	F	F	F	F	C	C
Surface Artery NB	F	F	F	F	F	F	N/A	N/A
I-93 SB Off-Ramp	F	E	F	D	F	D	N/A	N/A

---

1. N/A: Not applicable

Source: Bechtel/Parsons Brinckerhoff

Table 1.8

ESTIMATED PEAK HOUR TRAVEL TIMES AND SPEEDS ON MAINLINE

	5A Mod		S Mod		T Mod		Z Mod	
Approach	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Northbound								
Speed (mph)	23	14	17	16	25	19	32	20
Time (min)	4.9	9.8	6.7	8.8	4.4	7.1	3.5	6.8
Distance (ft)	9,869	12,097	9,869	12,097	9,869	12,097	9,869	12,097
Southbound								
Speed (mph)	15	17	16	33	15	36	21	36
Time (min)	12.3	7.3	11.9	3.7	12.4	3.4	8.8	3.5
Distance (ft)	16,440	10,920	16,440	10,920	16,440	10,920	16,440	10,920

Source: Bechtel/Parsons Brinckerhoff

Table 1.9

ESTIMATED PEAK HOUR TRAVEL TIMES AND SPEEDS ON LEVERETT CIRCLE/ STORROW DRIVE CONNECTORS

	5A Mod		S Mod		T Mod		Z Mod	
Approach	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Storrow Drive To I-93 Southbound								
Speed (mph)	26	17	17	14	17	13	28	33
Time (min)	6.2	9.6	8.5	10.6	8.6	10.6	7.9	6.6
Distance (ft)	14,340	14,210	12,990	12,860	12,650	12,520	19,165	19,035
I-93 Northbound To Storrow Drive								
Speed (mph)	12	12	13	14	23	17	25	27
Time (min)	7.4	9.5	6.8	8.3	3.8	6.5	6.3	6.8
Distance (ft)	8,019	10,247	7,769	9,997	7,619	9,847	13,909	16,137

Source: Bechtel/Parsons Brinckerhoff

TABLE 1.10

ESTIMATED QUEUES AND QUEUE SPEEDS
AREA NORTH OF CAUSEWAY STREET ALTERNATIVES ANALYSIS

	5A Modified				S Modified				T Modified				Z Modified			
	Queue (ft)		Average Queue Speed (mph)		Queue (ft)		Average Queue Speed (mph)		Queue (ft)		Average Queue Speed (mph)		Queue (ft)		Average Que Speed (mph	
Location	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
I-93 Mainline Southbound																
Off-Ramp To City Square	1700		9													
On-Ramp From Route 1/ City Square	8540	4720	10	10					9260		12					
On-Ramp From Route 1					3160		12									
On-Ramp From Leverett Circle					4950		11						4030		10	
On-Ramp From New Chardon St.					1890	370	10	11	1590	490	10	10				
I-93 Mainline Northbound																
On-Ramp From Sumner Tunnel	2110	4870	10	10	3620	5820	10	10	1400	3650	9	10		2650		1
On-Ramp From Causeway		2390		9												
On-Ramp From Leverett Circle		380		10												
Storrow Drive EB To I-93 SB																
Upstream Of Leverett Circle	1210	4400	8	7	670	3630	7	6	700	3680	4	4				
On-Ramp Lane Drop										1400		6				
On-Ramp Merge With I-93 SB					2530		10						2270	9		
I-93 NB To Storrow Drive WB																
On-Ramp From I-93 SB													2170	10		
Off-Ramp To Nashua Street					630		6									
On-Ramp From I-93 SB	3960	700	10	10												

Table 1.11

COMPARISON OF VHT AND VMT MEASURES (ENTIRE PROJECT STUDY AREA)

Scheme	VHT	VMT
5A Modified	634,000	5,202,000
S Modified	580,000	5,200,000
T Modified	595,000	5,180,000
Z Modified	619,000	5,231,000

Table 1.12

COMPARISON OF VHT AND VMT MEASURES (DOWNTOWN AND AREA NORTH OF CAUSEWAY STREET DISTRICTS)

Scheme	VHT	VMT
5A Modified	221,000	1,551,000
S Modified	190,000	1,556,000
T Modified	204,000	1,513,000
Z Modified	205,000	1,604,000

Source: Bechtel/Parsons Brinckerhoff

North of the Charles River, there would be no conflicts with pedestrian/bicycle circulation; although a proposed path from Rutherford Avenue to the Charles River would be adversely affected by overhead highway decks and columns.

Option S Modified. The most serious adverse impact of option S Modified would be conflicts between the Causeway Street on-ramp and the pedestrian connection between Causeway Street and the river. The ramp, rising above grade in transition to the elevated bridge structure, also would cause the width of the walkway to be reduced substantially. Lovejoy Wharf would not be adversely affected.

On the north bank of the Charles River, elevated ramp and mainline structures would cover a substantial share of planned pedestrian paths. Overhead structures would dominate this portion of the visual environment, and the shadow impacts of highway traffic would affect the aesthetic quality of this path. Pedestrian/bicycle movement, however, would be essentially unobstructed. The path from Rutherford Avenue to the Charles River would be largely under elevated highways, limiting visibility and landscaping.

Option T Modified. On the south bank of the Charles River, impacts of T Modified would be similar to those of S Modified. On the north bank of the Charles River, Option T Modified would have fewer ramps than S Modified, or Z Modified, and would therefore have less impact on the proposed walkway and bikeway west of the new I-93 bridges, although major highway structures would be present with this option. The Rutherford Avenue path would have problems similar to those of S Modified.

Option Z Modified. Generally, the impacts of Z Modified are similar to those associated with S Modified and T Modified. A major difference is that Z Modified would not incorporate entrance and exit ramps at Causeway Street. As a result, there would not be a major conflict with the walkways planned between Causeway Street and the MDC locks walkway. The result for the Causeway Street pedestrian environment would be a more spacious, pleasant, and clearly defined pedestrian connection, capable of accommodating substantially greater volumes of pedestrian traffic. Lovejoy Wharf would not be affected.

On the north bank of the Charles, compared to the other options, Z Modified would cover the largest area with highway structure, including the paths used for pedestrian and bicycle circulation. While pedestrian/bicycle circulation would be unimpeded, the visual environment would be adversely affected. Problems similar to those of S Modified and T Modified would make the Rutherford Avenue path difficult to implement.

1.3.7(a) Comparison Of Bicycle/Pedestrian Impacts

Z Modified is the only option that would not intrude upon the pedestrian connection between Causeway Street and the MDC locks walkway. For this reason, the Z Modified alignment is superior to the other alternatives in terms of its effects on the south bank of the Charles River. The impacts of 5A Modified on the south bank would be clearly worst among the options.

On the north bank of the Charles River, none of the options would conflict functionally with pedestrian/bicycle circulation alongside the Charles River. All would involve elevated structures that would create shadows and substantial visual intrusions, which would alter the environment in which pedestrian and bicycle movement occurs. Z Modified would cover a broader area than the other options, including the river edge on the north bank west of the MBTA railroad tracks. Implementation of the path from Rutherford Avenue to the Charles River would be made difficult by overhead structure in options S Modified, T Modified, and Z Modified; relocation of this path may be necessary.

1.4 LONG-TERM ENVIRONMENTAL IMPACTS

This section describes the environmental impacts of the four roadway options for the Area North of Causeway Street. Included are discussions of air quality, noise, wetlands, aquatic ecology, water quality and floodplains, waterways (navigation), land use, open space and parkland, visual conditions, relocation, and historic impacts. Public interests in tidelands are addressed in several sections below, notably wetlands, waterways, land use, open space and visual impacts. In general, impacts are described for each option and then a summary comparison is provided. In cases where impacts are similar for all, or groups of options, an overall description of the impact is provided.

1.4.1 Air Quality

Both microscale (localized) and mesoscale (areawide) analyses were performed to determine the relative effects of each option on air quality receptor sites located throughout the project study area. The data presented here represent the relative air quality values associated with each option, not the absolute values. [The absolute numerical results presented here differ somewhat from the results presented in Part I of the SEIS/R for the Proposed Action because this conceptual evaluation is based on a less detailed traffic analysis than was conducted for the projectwide Proposed Action. The data from the assignment model were further calibrated (as described in Part I) using actual or planned signal timings at congested intersections and the following procedures detailed in the 1985 Highway Capacity Manual.] The microscale values for 5A Modified, S Modified, and T Modified were determined based on relative air quality changes compared with Z Modified.

1.4.1(a) Mesoscale Analysis

The quantities of motor vehicle-related pollutants emitted vary for each option considered. The assessment of "pollutant burdens" (i.e., the tons of pollutants emitted each year for each option) provides an indication of the general change in air quality in the region associated with each option and is useful in assessing relative changes in concentrations of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), and ozone. Carbon monoxide, HC, and NO_x pollutant burdens were computed for each option based on the estimated VMT, VHT, average travel speed, and vehicle mix for all major roadways in the study area and for the six zones (subareas) representing the primary study areas in Boston affected by the proposed project. (A detailed description of the traffic data, assumed meteorological conditions, and the EPA MOBILE 4 Mobile Source Emissions Program used to estimate pollutant emissions is presented in the Air Quality Technical Support Document.)

Mesoscale Analysis Summary. Estimated annual areawide emissions of CO, HC, and NO_x for the year 2010 for each option are provided in Tables 1.13, 1.14, and 1.15. These tables show that Z Modified would result in slightly lower emission burdens than the other options considered. Increased emission burdens are predicted for S Modified, and T Modified, with 5A Modified showing the highest emission burdens. The increase in

Table 1.13

ANNUAL AIR QUALITY EMISSIONS BURDEN FOR CARBON MONOXIDE (TONS PER YEAR)

YEAR: 2010

	Options			
Affected Area	**5A Modified**	**S Modified**	**T Modified**	**Z Modified**
Area North of Causeway				
Highways and Ramps	1,909	1,499	1,521	1,463
Local Streets	1,259	988	1,105	1,000
Rest of Project				
Highways and Ramps	3,684	3,989	3,953	3,742
Local Streets	9,688	9,608	9,737	9,747
Totals	16,540	16,084	16,316	15,952

Source: Bechtel/Parsons Brinckerhoff

Table 1.14

ANNUAL AIR QUALITY EMISSIONS BURDEN FOR HYDROCARBONS (TONS PER YEAR)

YEAR: 2010

	Options			
Affected Area	**5A Modified**	**S Modified**	**T Modified**	**Z Modified**
Area North of Causeway				
Highways and Ramps	286	251	241	251
Local Streets	232	167	195	171
Rest of Project				
Highways and Ramps	663	695	692	665
Local Streets	1,901	1,798	1,823	1,821
Totals	3,082	2,911	2,951	2,908

Source: Bechtel/Parsons Brinckerhoff

Table 1.15

ANNUAL AIR QUALITY EMISSIONS BURDEN FOR NITROGEN OXIDES (TONS PER YEAR)
YEAR: 2010

	Options			
Affected Area	**5A Modified**	**S Modified**	**T Modified**	**Z Modified**
Area North of Causeway				
Highways and Ramps	250	233	220	237
Local Streets	125	113	118	113
Rest of Project				
Highways and Ramps	627	650	652	628
Local Streets	931	903	914	917
Totals	1,933	1,899	1,904	1,895

Source: Bechtel/Parson Brinckerhoff

pollution burdens between the lowest (Z Modified) and the highest (5A Modified) emissions burdens are approximately 4 percent for CO, 6 percent for HC, and 2 percent for NO_x.

1.4.1(b) Microscale Analysis

Microscale air quality modeling was performed for each option for the year 2010 using the MOBILE 4 and CAL-3QHC Air Quality Dispersion Model to estimate CO levels in the project area adjacent to heavily congested roadways. (A description of the procedures used in completing these estimates is provided in the Air Quality Technical Report.) Estimates were completed for the same 39 locations discussed in Chapter 4 of Part I. The analysis was based on estimated traffic levels during the peak 8-hour traffic period (10 AM to 6 PM; 8-hour CO values are critical when determining compliance with the NAAQS). An 8-hour background value of 1.8 ppm was developed in accordance with procedures established with EPA and DEP.

Microscale Analysis Summary. The results of the CO miscroscale analysis are summarized in Table 1.16. Estimates of 8-hour concentrations of CO for midblock and intersection locations in the vicinity of each analysis site are provided. The primary result of the analysis is that predicted 2010 concentrations for all options will be in compliance with the National and Massachusetts AAQS at all locations analyzed.

Substantial variations (assumed to be 0.5 ppm for the purpose of this evaluation) between options occur at only a few of the intersections analyzed. The predicted results at Receptors 3, 5, 6, and 12 (Leverett Circle, Causeway and Haverhill Streets, Causeway and Beverly Streets, and North Street and Surface Artery) are all higher with 5A Modified, S Modified, and T Modified than with Z Modified. The predicted results at Receptors 2 and 7 (City Square, and North Washington and Commercial Street) are higher with 5A Modified than the other options. The predicted results at Receptor 15 (State Street and Surface Artery) are higher with Z Modified than the other options. In all cases the results are well below the 8-hour CO standard of 9 ppm, and the air quality difference between the options is not significant.

1.4.2 Noise

This section describes the noise impacts of the various options. The existing noise environment in the area of the Proposed Action is presented in Chapter 5 of Part I of the SEIS/R. Noise impacts of each of the options were assessed at seven sensitive receptor sites in the Area North of Causeway Street. Predicted noise levels were compared with existing noise levels; year 2010 baseline noise levels; and with the FHWA criteria for the applicable land use category (see Figure 1.11).

The methodology used in the noise analysis is based on the assumption that vehicle speeds do not differ significantly between options. Variations in noise levels among the options have been assessed based on traffic volumes on links nearest to the various receptor locations. The noise levels predicted are deemed to be conservative.

1.4.2(a) Traffic Noise Levels

The four options have very similar noise impacts in the Area North of Causeway Street.

In comparison with existing noise levels, options 5A Modified, S Modified, and T Modified will have noise levels lower than existing conditions at three locations (18, 27, and 28);

and noise levels higher than existing conditions at four locations (17, 29A, 29B, and 39). Option Z Modified will have noise levels lower than existing conditions at one location (18); the same as existing levels at one location (27); and higher than existing levels at five locations (17, 28, 29A, 29B, and 39).

In comparison with future baseline noise levels (2010) option 5A Modified would have lower noise levels at four locations; higher noise levels at two locations; and mixed effects at one location. Options S Modified and T Modified would have lower noise levels at three locations; higher levels at two locations; no effect at one location; and mixed effects at one location. Option Z Modified would result in lower noise levels at three locations and higher noise levels at four locations.

In comparison with FHWA noise abatement standards, all four options would approach or exceed the specific noise level criterion at six of seven locations (site 29B is the only location where the noise criterion would be met). Existing noise levels would approach or exceed FHWA Noise Abatement Criteria (NAC) at five out of seven sites.

1.4.2(b) Ventilation Noise Levels

Within the Area North of Causeway Street, one ventilation building is required for options 5A and S Modified and two ventilation buildings for option T Modified. Ventilation buildings are not required for option Z Modified because there are no tunnel sections in that option.

The project design criteria developed for exterior noise levels caused by ventilation buildings and associated equipment are consistent with the City of Boston Code, Ordinances, Title 7, Section 50. The limits are 50 dBA during the nighttime and 60 dBA during the daytime at the lot lines of nearest residences, and 70 dBA at all times for industrial areas. The project design criteria will also comply with Department of Environmental Protection (DEP) guidelines that a facility should not increase the broad band noise level by more than 10 dBA above the ambient (existing) level and that noise with a pure tone component shall not exceed ambient level by 5 dBA or more. The DEP guidelines apply to locations at the property line as well as at the nearest inhabited residences.

All of these standards will be met by ventilation buildings in the Area North of Causeway Street.

1.4.2(c) Mitigation Measures

An area or a particular receptor must be considered for noise abatement if predicted traffic-related noise levels either approach or exceed FHWA NAC or substantially exceed existing levels. Either of these two conditions is considered a noise impact. Abatement measures are to be considered to the extent that reasonable opportunities exist to control noise (see Part I of the SEIS/R, Chapter 5).

Under all options, all of the receptor locations (except 29A and 29B) require noise abatement consideration. Site 29A (Leverett Circle) is not noise sensitive, and site 29B satisfies the FHWA NAC of not approaching or exceeding 67 dBA (NAC for Category B land use).

Noise barriers for location 17 (Edward Everett House) of a reasonable height are not effective for buildings this tall, and hence they are not likely to be built.

For locations 18 (Paul Revere Landing Park, north bank), 27 (Charles River Building), and 28 (Paul Revere Landing Park, south bank), noise barriers are not recommended because negative visual impacts would result from long and continuous barriers and because of the pedestrians' need to reach adjoining waterfront areas from these receptor locations.

Location 39 (North Point) is currently not noise sensitive. However, this area is slated for residential and other noise sensitive development in the near future. Thus noise abatement may be considered for this site. Noise abatement is considered feasible and could include noise barriers on ramps and viaducts, or within the buildings themselves.

1.4.2(d) Comparison Of Options

Of the four proposed options, S Modified and T Modified are expected to be marginally better than 5A Modified and Z Modified. In all locations the differences between options are in the range of 1 to 2 dBA. (A 1-dBA difference is deemed to be imperceptible and insignificant.)

1.4.3 Wetlands, Aquatic Ecology, And Water Quality

The aquatic resources located in the Area North of Causeway Street are associated with the Charles River and the Millers River. The new Charles River dam, built in 1976, effectively eliminated tidal fluctuations in both of these water bodies, and they are thus maintained as freshwater ecosystems. [A detailed description of the aquatic resources is contained in the Section 404(b)(1) analysis presented in an appendix to the SEIS/R. The functions and values of these aquatic resources are also discussed in the appendix.]

1.4.3(a) Charles River Impacts

The quality and productivity of this ecosystem are largely or entirely related to factors which will generally not be affected by any of the options: flow rate, which is a function of rainfall; water surface elevation, a function of the releases at the dam; the quality of point source discharges, a function of compliance with the National Pollutant Discharge Elimination System (NPDES) permits; the quality of urban runoff, a function of rainfall frequency and land use practices; activities in the Charles River watershed; and former activities that affected the quality of river sediments and surviving shoreline vegetation. The direct loss of aquatic habitat is minor for options S Modified, T Modified, and Z Modified. Option 5A Modified causes long-term loss of bottom habitat that is three times greater than the other options, because of its ramps in the Charles River.

Vegetated wetlands in the project area are sparse, of low quality, and have little ecological value for fish or wildlife. Pile caps in the Charles River, and tunnel boxes in option T Modified, will be located several feet below the mudline, thus allowing backfill to be recolonized by benthic organisms. Neither cylindrical nor slab piers for bridges will adversely affect fish movement and may provide some additional habitat. There will be no effect on anadromous fish since bridge supports are substantially less restrictive than the locks in the new Charles River dam through which all such fish must pass. Geometric considerations preclude locating the 5A Modified tunnel box (for movements between Storrow Drive and I-93) below the mudline. The tunnel box eliminates productive habitat (about 1.68 acres) in a valuable resource area and thus has substantially greater long term impacts on aquatic resources than the other options.

The potential for adverse effects from shade on resident aquatic organisms or anadromous fish is negligible. Vertical clearance over the water is at a height which enables a substantial amount of direct light to reach the water even if it is assumed that the entire 300-foot-wide crossing consists of continuous bridge without gaps. Option Z Modified involves the greatest amount of shading over the Charles River (25 percent greater than S Modified, 29 percent greater than T Modified, and 64 percent greater than 5A Modified), but it includes a 30-foot-wide gap and two 10-foot-wide gaps within the 300-foot-wide crossing (see Table 1.17). Shading theoretically could depress primary production which requires direct lighting, but this is highly unlikely because of the high mean annual flow rate in the Charles River (about 450 cubic feet per second), and the rapidity with which phytoplankton can bloom.

All four options would increase to some degree the pollutant loadings that are typical of urban runoff. There would be no clear improvement in pollutant concentrations for constituents such as heavy metals, for which U.S. Environmental Protection Agency (EPA) criteria are currently exceeded, and concentrations of some constituents such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Organic Carbon (TOC) which would increase in Z Modified and the other options [see Section 13.2.3(c) of Part I].

The extent to which pollutant loadings increase is related to a complex of factors, such as total area of highway surface and vehicle miles travelled on the portions of the I-93/Route 1 interchange which are open to rainfall. Z Modified would have the greatest runoff impacts, followed by S Modified, T Modified, and 5A Modified in that order.

A variety of measures of varying effectiveness exist to mitigate the discharge of chemicals present in runoff. These include design of the drainage system to discharge de-icing chemicals to the saline environment downstream of the dam, regular sweeping of the highway decks, creation of wetland environments which may reduce pollutant loadings reaching the rivers, and use of oil separators and other treatment technologies in the drainage system. Since there are no currently accepted standard practices to reduce the concentration of pollutants in storm water runoff from highways, for any option, a mitigation program could to be developed in consultation with EPA, the U.S. Army Corps of Engineers (USACE), DEP, and the Conservation Commissions of Boston and Cambridge.

1.4.3(b) Millers River Impacts

Option 5A Modified involves minimal change in the Millers River compared to the other three options. If the aquatic and wetland environment were healthy and productive, its impact would therefore be substantially less severe than that of the other options. Studies of Millers River, however, indicate that it is highly polluted and has very low productivity. These conclusions are based on the following:

- Dissolved oxygen is less than 5.0 mg/l, which is required for Class B waters containing a warm water fishery.
- Fecal coliform bacteria concentrations are high and not in compliance with water quality standards.
- Electroshocking in one-third of Millers River, including the area near the Charles River containing the best habitat, did not result in any fish being collected.

Table 1.17

FACTORS RESULTING IN AQUATIC IMPACTS

Factor	Location	5A Mod	S Mod	T Mod	Z Mod
Vegetated Wetland Filled (acres)	Charles River	0	0	0	0
	Millers River	0.01	0.44	0.44	0.44
	Total	0.01	0.44	0.44	0.44
Bottom Habitat[1] Filled (acres)	Charles River	1.87[2]	0.07	0.06	0.07
	Millers River	0.03	0.51	0.51	0.51
	Total	1.90	0.58	0.57	0.58
Area Under Structure (acres)	Charles River	2.69	3.53	3.42	4.43
	Millers River	0	1.23	1.23	1.23
	Total	2.69	4.76	4.65	5.66

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1. Based on pile caps below the mudline for the Charles River and pile caps above the mudline for the Millers River
2. Includes 0.5 acre of fill in tidal waters and 1.18 acres of nontidal water for the tunnel box on the south side of the Charles River

Source: Bechtel/Parsons Brinckerhoff
Based on J.M. Cortell and Associates, 1990, Draft Aquatic Resources Functions and Values (Volume 1)

- Over 10 gallons of sediment produced only one sludge worm.

Shading from bridges associated with options S Modified, T Modified, and Z Modified would have a greater effect on Millers River than on the Charles River because the entire open water portion of the river would be affected, and there is little opportunity for phytoplankton recruitment from other sources. However, substantial reduction in primary productivity is unlikely to affect higher trophic levels in the Millers River because the aquatic environment is too polluted to support such organisms. The shading of the river in option Z Modified would be greater than in S Modified and T Modified, in which afternoon sunlight would penetrate under the structure to some degree. A reduction in primary and secondary productivity in the Millers River would have little adverse effect on the Charles River because the Millers River is close to the mouth of the Charles River and because its contribution to the Charles River ecosystem is currently small.

The shoreline vegetation along the Millers River consists primarily of about 0.44 acre of wetlands. Representative species include indigobush, Eastern cottonwood, and purple loosestrife. These species are not shade tolerant and will lose vigor or will be replaced by other species which are more tolerant of shade. The aquatic environment will essentially be unaffected by this change since the vegetation is located above ordinary high water. If vegetated banks become denuded, there would be increased potential for erosion, but the presence of roadway decking overhead would intercept much of the precipitation and species having a higher tolerance of shade would be established. An evaluation of the benefits of relocating the Millers River is being conducted. If feasible, this could improve the aquatic environment in Millers River compared to what it is at present.

The effect of runoff on the Millers River would be similar to that described above for the Charles River.

1.4.3(c) Summary Of Impacts

The factors indicated in Table 1.17 include three important sources of long-term adverse impacts on the Charles River and Millers River ecosystems associated with each of the options. Direct loss of habitat and other values resulting from fill for tunnel box or bridge piers is permanent. Shade from bridge decks would tend to inhibit the vigor of shade intolerant vegetation located along the margin of the Millers River. Shade could potentially reduce primary production (phytoplankton) in the waterways.

Runoff and associated pollutant loadings would be greatest in Z Modified followed in order by S Modified, T Modified, and 5A Modified. An appropriate runoff mitigation program could be developed in coordination with the environmental agencies.

Design variations of the options which are important to this discussion include location, number, span length (which relates to the number of piers), and width of bridges. Option 5A Modified crosses the Charles River on split bridges separated by about 100 feet at the south bank and about 200 feet at the north bank and almost entirely avoids the Millers River. It thus has the least impact on vegetated wetlands and involves the smallest waterway shading of the four options. However, Option 5A Modified causes the greatest impact on water bottom habitat because of fill required for a tunnel box along the south shore of the Charles River and slab piers which are used to support the bridges. Alternate bridge types, if possible, may reduce the number of bridge piers in Z Modified and other options.

The bridges associated with Options S Modified, T Modified, and Z Modified all involve bridges that are relatively close together and which cross the Charles River in parallel. The alignment of these options is also parallel to the long axis of Millers River. The result is greater shading of the aquatic habitat (which is greatest for Z Modified). Relocation of the Millers River is a potential mitigation measure which, if feasible, would be consistent with the Department's commitment to reconstruct the river.

1.4.4 Floodplains

The water surface elevation of the Millers River and the Charles River is controlled by the new Charles River dam and high-capacity pumps which discharge into the Boston Inner Harbor downstream of the dam. The 100-year flood elevation, as depicted on maps published by the Federal Emergency Management Agency (FEMA), is 4 feet above mean sea level. This event is essentially contained within the banks of these water bodies.

The unavoidable loss of storage capacity associated with displacement by features of the proposed Artery/Tunnel Project is negligible and will not affect the 100-year water surface elevation. None of the options, including T Modified, will impair the flow of the Charles or Millers River and none of the options will impair the functioning of facilities to control the water surface elevation.

The banks of the Charles River and the Millers River are steep and have an elevation of about 10 feet above mean sea level. This is about 6 feet higher than the 100-year flood elevation.

The discharge impacts on the 100-year water surface elevation are negligible in all options due to the small volume of runoff compared to the flow rate of the Charles River. Moreover, the water surface elevation is controlled by the MDC. Releasing water into the Boston Inner Harbor during periods of high flow will not result in flooding nor aggravate flooding downstream of the project. Therefore, all of the options comply with Federal Executive Order 11988 which addresses the importance of avoiding encroachments on 100-year floodplains.

1.4.5 Waterways/Navigation

Existing navigation conditions in the Charles River are discussed in Chapter 14, in Part I of the SEIS/R. Recreational navigation uses predominate in the Charles, and commercial shipping, while it does exist, is limited. The waters below the proposed Charles River crossing (located between the two Charles River dams) are used almost exclusively by vessels navigating between Boston Harbor and the Charles River Basin, and are not a recreational destination in and of themselves.

Long-term navigation impacts are associated with the proposed bridge piers. Comparative impacts for the various options can be determined by examining the size, number, and location of the piers. Unless noted otherwise, all piers will measure 15 feet in diameter.

The physical constraints governing pier locations and vertical clearances are:

- Size of the largest vessel that can pass through the commercial lock
- Regulated vertical clearances above the locks

The existing lock can accommodate a 300-foot barge and, as a result, bridge piers must be placed so that a vessel of that size can pass below bridge structures. (The 300-foot barge constraint is very conservative, as no vessel of that size has passed through the locks in recent years.)

Vertical clearance above the navigation channel must be 30 feet.

Option 5A Modified. Option 5A Modified uses a different pier scheme from the other options. The northbound mainline and the ramp from Storrow Drive to I-93 northbound would be located south of the existing high bridge on two independent structures, supported by two common slab piers (see Figure 1.12). These piers would measure 90 by 15 feet and would rise from below the mudline to a point above the waterline. The slab piers would form a base on which individual piles supporting the bridge superstructure would rest. The piers for the northbound bridges would be located just south of Lock 1 in the new Charles River dam and just south of the river's northern bank. The piers would be located well outside the navigation channel and would not impair navigational conditions in any way.

The southbound mainline and ramps would be carried on two independent bridges supported by two more massive, but similar slab piers. The southern pier would measure 176 by 15 feet and run parallel to the river bank approximately 45 feet from the southern bank. The northern pier would measure 216 by 15 feet and would lie 100 to 150 feet from the northern river bank. The northern piers would lie well out of the shipping channel and would not impact navigational conditions. However, due to their size, the southbound bridge piers would probably be surrounded by a tendering system.

The overhead restriction created by the alignment of the northbound I-93 bridge over the Charles River dam would affect the potential to remove existing lock gates or install new gates during future maintenance programs.

Option S Modified. S Modified would cross the Charles River on three independent bridges. These bridges would be supported by 15-foot diameter piers, 17 of which would lie in the Charles River (see Figure 1.12). The pier spans would be 250 feet, and none of the piers would block the navigation channel. Most piers would be protected by fenders or dolphins, and a 300-foot barge (the largest vessel which can lock through the Charles River dam) will be able to navigate safely with the assistance of two tugboats.

Option T Modified. T Modified uses a combination of bridges and tunnels to cross the Charles River (see Figure 1.13). The tunnels will carry the Leverett Circle ramps and will lie completely below the mudline. The T Modified tunnels would have no long-term navigational impacts.

The mainline movements and ramps would be carried on two bridges with fifteen 15-foot diameter piles in the Charles River. The bridges would have 250-foot spans and none of the piers would block the navigation channel. Most piers would be protected by fenders or dolphins, and a 300-foot barge will be able to navigate safely with the assistance of two tugboats.

Option Z Modified. Z Modified uses three bridges to carry the mainline and ramp movements across the Charles River. The Z Modified bridges would have seventeen 15-foot diameter piers in the river (see Figure 1.13). These piers would be protected by fenders, and a 300-foot barge will be able to navigate safely with the aid of two tugboats.

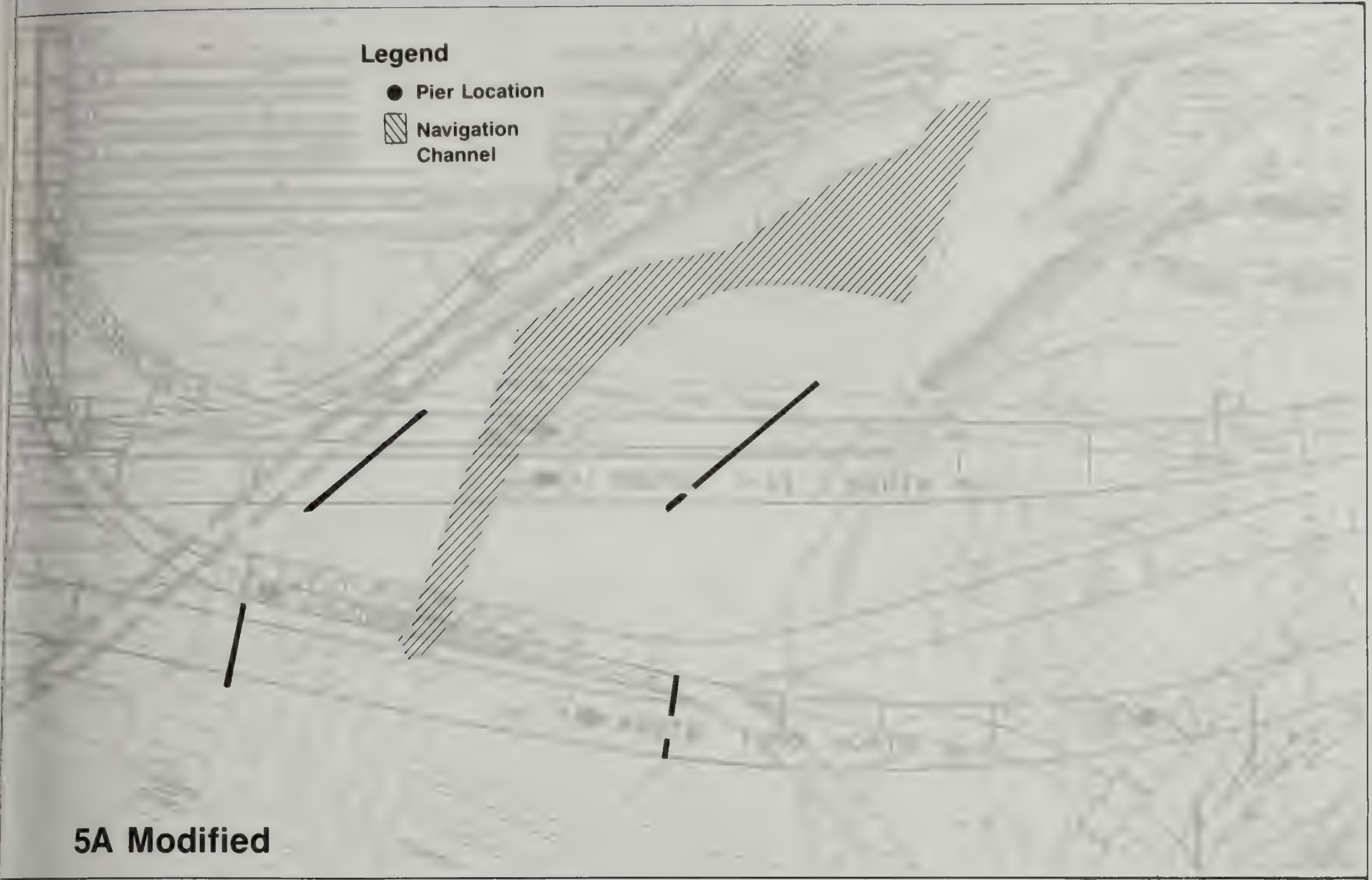
Conclusions. Option 5A Modified, with four piers in the Charles River and 400-foot spans between those piers, would have a minimal impact on navigation conditions in the river. T Modified, with 15 piers in the water and 250-foot pier spans, would have a minor impact on navigational conditions in the river. Vessels would be able to navigate safely under T Modified bridges, but would have to avoid the western bridge piers. There would be piers located on one side of the S-shaped path that larger barges would have to follow to be properly aligned to pass under the bascule bridge. S Modified and Z Modified would have moderate navigation impacts in the Charles River. Both options would have 17 piers located in the water, with 250-foot spans between those piers. All vessels would be able to navigate safely under the S Modified and Z Modified bridges. However, there would be bridge piers located on both sides of the S-shaped path that barges will have to follow to be properly aligned to pass under the bascule bridge. (Alternative bridge types with fewer piers are also being studied.)

1.4.6 Land Use Impacts

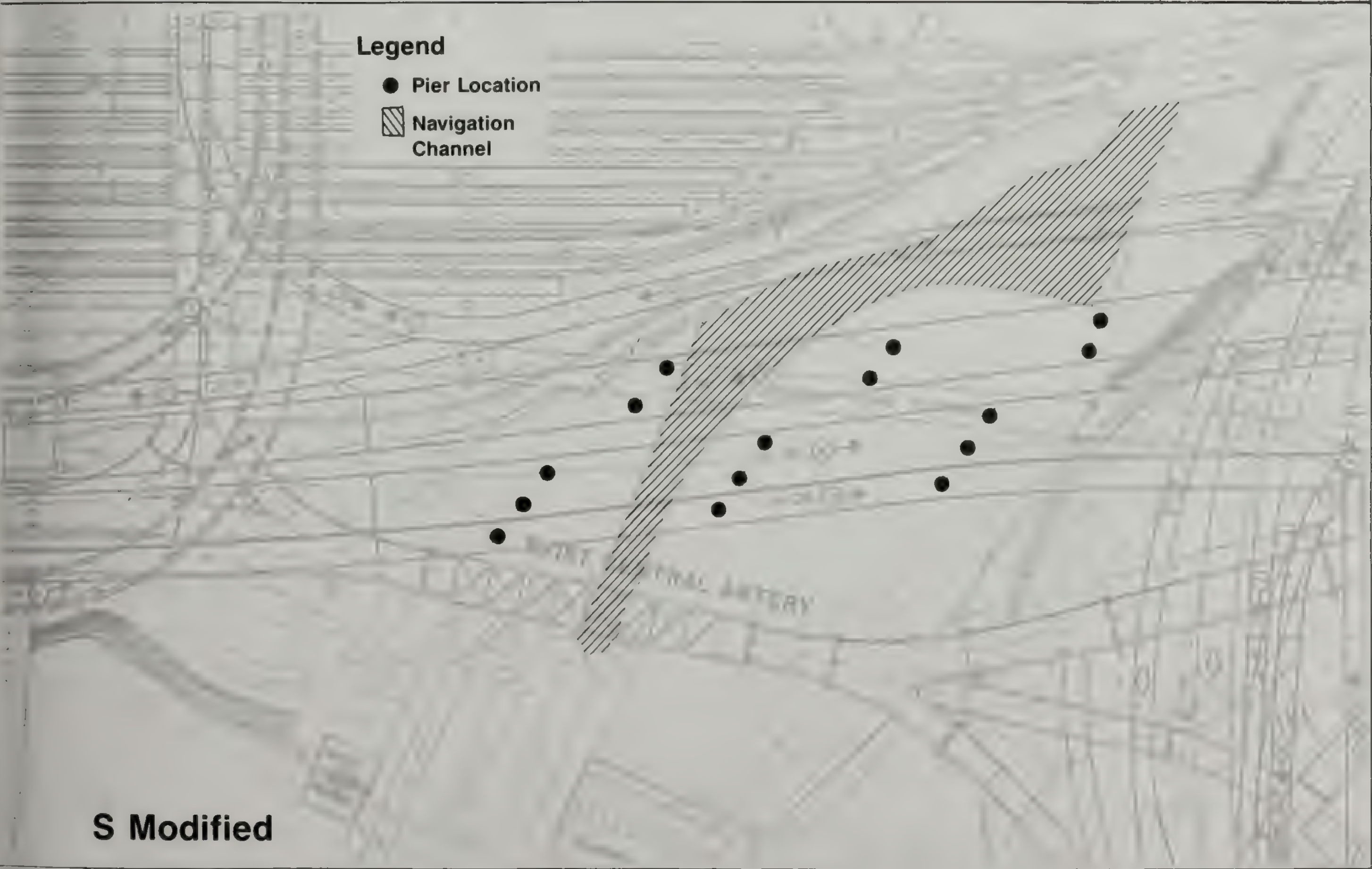
For the purposes of assessing land use impacts, the Area North of Causeway Street comprises land near North Station (including the Bulfinch Triangle and the land lying between Causeway Street and the Charles River), a portion of Charlestown, the North Point area of Cambridge, and that portion of the West End which is closest to the project area. This area has undergone substantial change in the last decade and many more changes are anticipated (see Section 8.1.1 of Part I of the SEIS/R). The removal of the existing Central Artery viaduct south of Causeway Street in all four options will complement ongoing redevelopment activity in the area. The impacts described below include only those items which vary between the options. [For a complete discussion of land use impacts in the Area North of Causeway Street see Section 8.2.8(a) of Part I of the SEIS/R.]

Option 5A Modified. Option 5A Modified is in direct conflict with both newly constructed and proposed development projects. The surface roadway between Leverett Circle and Martha Way runs through the site of the newly constructed Suffolk County Jail and the Storrow Drive/Central Artery connection tunnels run through the new addition to the Spaulding Rehabilitation Hospital. This option would necessitate underpinning the commuter railroad tracks, and removal of a 100-foot bay of the Charles River Building and the loading dock of the Stop and Shop Building. A ventilation building would be constructed on the southwestern portion of the Charles River Building site. Boston Sand & Gravel operations would be impacted to a minor extent.

Impacts on proposed developments may include some requirements for modest modifications to the ventilation structures and garage ramps of the proposed new MBTA North Station underground garage. More serious is the incompatibility of this option with the proposed arena and commercial development. The tunnel from Storrow Drive to I-93 southbound conflicts with the eastern column line of the new Boston Garden and the off-ramp to Causeway Street forces garage ingress/egress, service and emergency vehicles, and new Boston Garden patron egress into a corridor far too narrow for thousands of people and many hundreds of cars. It is currently uncertain what impact structural modifications to the new Boston Garden design would have on that project's budget and schedule.



5A Modified



S Modified

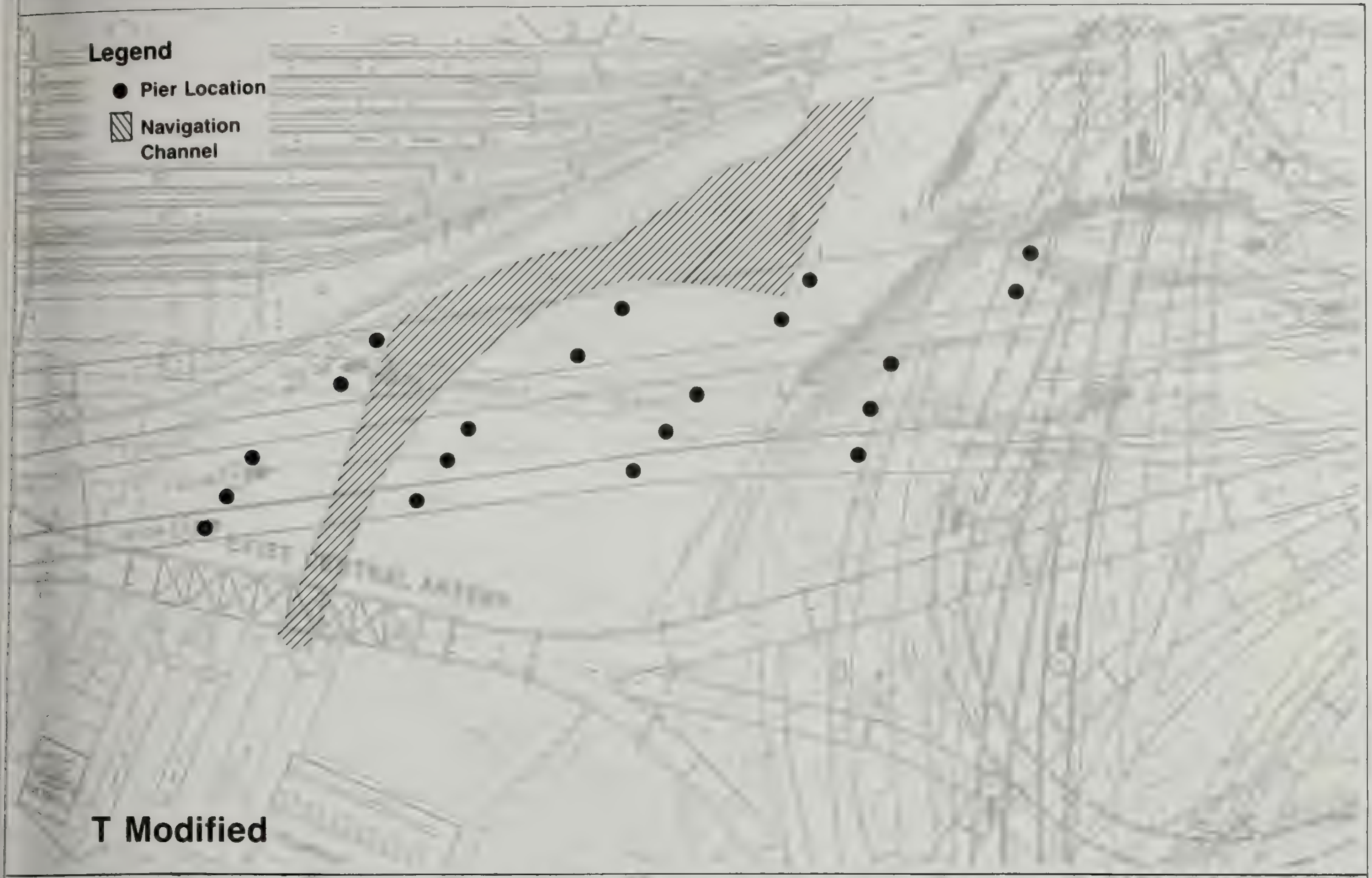
FIGURE

1.12

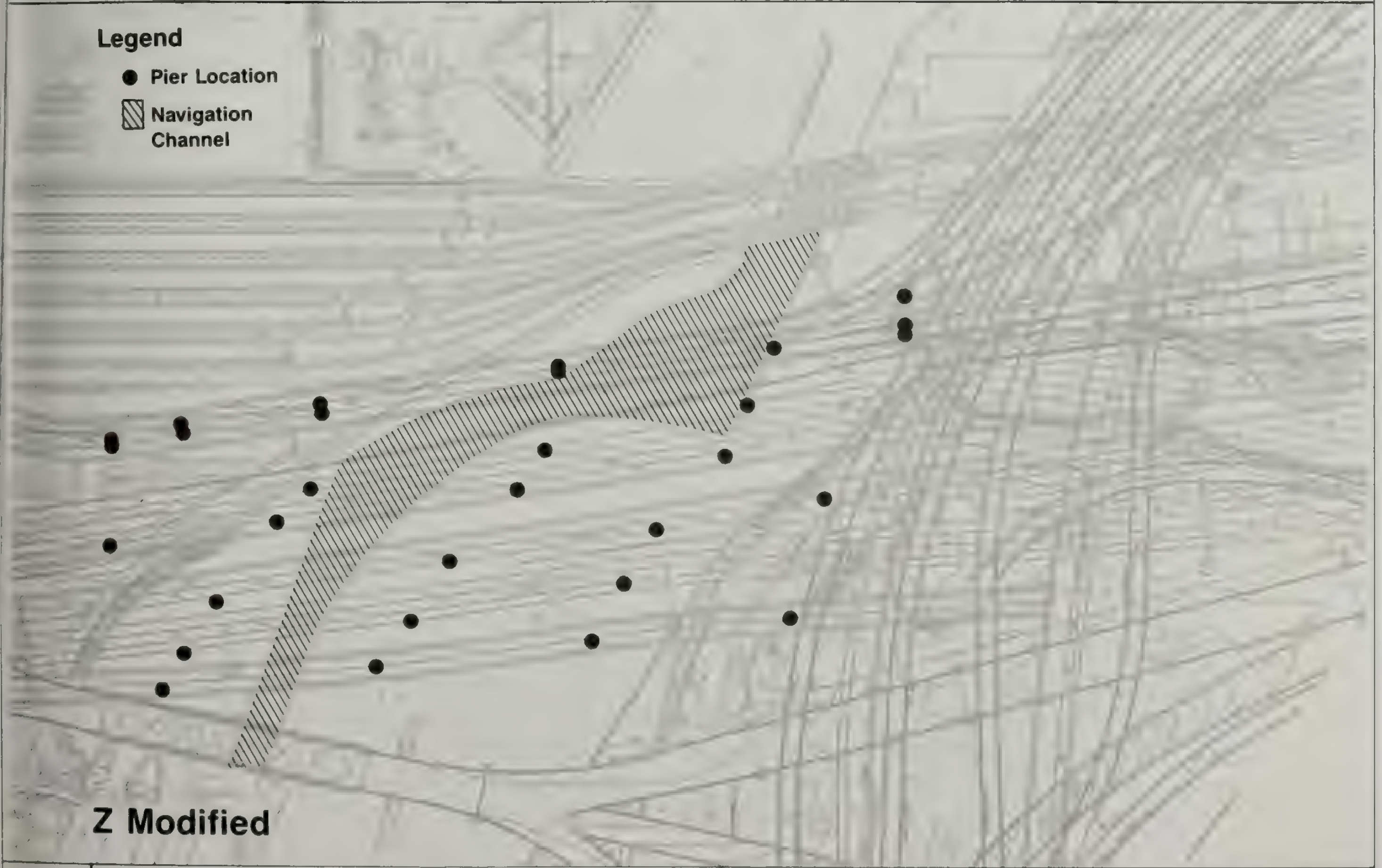
Pier Locations 5A Modified And S Modified

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 100 200 Feet



T Modified



Z Modified

FIGURE 1.13

Pier Locations T Modified And Z Modified

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 100 200 Feet

5A Modified would have no impact on land in Cambridge.

Option S Modified. Option S Modified would have impacts on a number of existing structures. Large bridge and viaduct structures would occupy much of the southwest area of Charlestown adjacent to the Charles River. The loading dock of the Charles River Building and the Boston Thermal steam plant would be taken; a new ventilation building would be constructed on the Boston Thermal site. Boston Sand & Gravel operations would be impacted to some extent. This option also would require underpinning of the commuter rail tracks. A narrow strip of vacant land at Charles River Park (a residential development) will be required for modifications to Leverett Circle.

Impacts on proposed developments may include some requirements for modest modifications to the ventilation structures and garage ramps of the proposed new MBTA North Station underground garage. More serious is the incompatibility of this option with the proposed arena and commercial development. The tunnel from Storrow Drive to I-93 southbound conflicts with the eastern column line of the new Boston Garden and the off-ramp to Causeway Street forces garage ingress/egress, service and emergency vehicles, and new Boston Garden patron egress into a corridor far too narrow for thousands of people and many hundreds of cars. It is currently uncertain what impact structural modifications to the new Boston Garden design would have on that project's budget and schedule. The Storrow Drive tunnel through the Massachusetts General Hospital (MGH) site may encumber underground development potential in that location.

The loop ramps (extending 30 to 90 feet further into Cambridge than CANA, 55 feet in height) would encroach on a portion of the North Point development area in Cambridge. The CANA project was incorporated into the planning for the North Point area, which was delineated as extending up to the CANA ramps. The loop ramps would not encroach on any sites for which specific development proposals exist, but may affect the future development potential of other parcels immediately adjacent to the ramps.

Option T Modified. Bridge and viaduct structures would occupy much of the southwest area of Charlestown adjacent to the Charles River, but to a lesser extent than in the other options. Option T Modified would require taking the Boston Thermal steam plant and would impact the Charles River Building loading dock. Boston Sand & Gravel operations would be impacted to some extent, and the commuter rail tracks would have to be underpinned. Ventilation buildings would be required at both the Boston Thermal site and inside the loop ramps on the north side of the Charles River. A narrow strip of vacant land at Charles River Park will be required for modifications to Leverett Circle.

Impacts on proposed developments may include some requirements for modest modifications to the ventilation structures and garage ramps of the proposed new MBTA North Station underground garage. More serious is the incompatibility of this option with the proposed arena and commercial development. The tunnel from Storrow Drive to I-93 southbound conflicts with the eastern column line of the new Boston Garden and the off-ramp to Causeway Street forces garage ingress/egress, service and emergency vehicles, and new Boston Garden patron egress into a corridor far too narrow for thousands of people and many hundreds of cars. It is currently uncertain what impact structural modifications to the new Boston Garden design would have on that project's budget and schedule.

The loop ramps (extending 20 to 80 feet further into Cambridge than CANA, 55 feet in height) would encroach on a portion of the North Point development area for which no specific development proposals currently exist. The ramps may affect the future development potential of parcels immediately adjacent.

Option Z Modified. The highway viaduct structures would occupy much of the southwest area of Charlestown adjacent to the Charles River, and would have a major impact on Boston Sand & Gravel operations. A temporary taking of the Boston Thermal ice annex would be required during construction. A narrow strip of vacant land at Charles River Park housing development would be required for modifications to Leverett Circle.

Option Z Modified will not have impacts on projected developments such as the proposed new North Station Green Line/Orange Line station and improvements to the commuter railroad station, the related parking garage, and the new Boston Garden complex above the garage. Option Z Modified also would not affect the parking garage above the proposed combined MBTA Orange Line/Green Line North Station facility bounded by Causeway, Canal, and Haverhill Streets. The new park to be built over the tunnel portal at Causeway Street will enhance the area and complement the ongoing redevelopment activity.

The loop ramps would encroach on a portion of the planned North Point development area for which no specific development proposals currently exist. The number, height, and location of the loop ramps (which extend 60 to 125 feet beyond the CANA ramps and are up to 110 feet in height) may affect the future development potential of parcels immediately adjacent.

1.4.7 Open Space And Parkland

The area of the Charles River from the Science Museum to the North Washington Street Bridge has been dominated by transportation and industrial uses for approximately 150 years, with practically no access to the river by pedestrians for recreational purposes, except for the new Charles River Dam and Paul Revere Landing Park. However, the MDC has for many years had a goal to extend the Esplanade on the north and south banks of the Charles River to connect to open spaces along the edge of Boston Harbor.

As a result of the MDC's efforts, the Area North of Causeway Street includes a number of existing and proposed open spaces along and near the Charles River. (The open spaces and parklands which are affected are shown in Figure 1.14.) These properties include existing parks, designated parkland, and commitments and future opportunities to expand the open space system.

The Artery/Tunnel options would affect the entire area, both positively and negatively whichever option is chosen, depending on location. Pedestrian access is potentially improved, while the Charles River crossing and I-93/Route 1 interchange will be visually dominant throughout the area, affecting the quality of open space for users of individual park sites and for pedestrians and cyclists travelling through this portion of the Charles River open space system. Accordingly, a wide ranging set of mitigating measures has been proposed for the area (see Section III of this SEIS/R).

As a part of the CANA planning process, and the 1985 FEIS/R, the Department agreed to facilitate to the greatest extent possible the MDC's goals for future parkland acquisition and development on the land available after completion of both the CANA and Artery/Tunnel highway projects. Specifically, continuous pedestrian access will be provided along the Charles River through Department-owned land and over the MBTA commuter railroad tracks. Land under and around the bridges and elevated loop ramps will be landscaped. Improved pedestrian access is to be provided from the Charlestown residential area to the Charles River. The Millers River is to be reconstructed and landscaped. Rights to all appropriate land will be conveyed to the MDC upon completion of both highway projects.

Comparison Of Open Space And Parkland Impacts. Figure 1.14 shows the many open space areas north of Causeway Street in relation to the four design options. There are four types of areas:

- o Existing parks (MDC Paul Revere Landing Park and the Leverett Circle/Storrow Drive/Esplanade portions of the MDC Charles River Reservation)
- o Designated parks not yet developed (MDC Nashua Street Parkland and GSA Parkland sites)
- o Proposed park improvements (improvements to the CANA area, Causeway Street access, Lovejoy Wharf, and potentially the North Point waterfront in Cambridge)
- o Pedestrian links owned by the MBTA

Table 1.18 addresses impacts on each of these areas by the four design options. Their effects can be summarized as described below.

Existing Parks. Scheme 5A Modified, with its eastern bridge farthest downstream, has the greatest effect on each portion of Paul Revere Landing Park: it passes over a corner of the north bank portion and the walkway on the Charles River dam and uses the largest area of the south bank portion, although parking can remain under low bridge decks. Schemes S Modified, T Modified, and Z Modified avoid the north bank and walkway portions and use less of the south bank portion, although parking is displaced by retained fill segments in each scheme.

Option 5A modified uses a small amount of land in the MDC Police parking lot at the Esplanade. Schemes S Modified and Z Modified reconfigure the traffic circle and convert some highway landscaping to paved area, while returning smaller areas of pavement to landscaping. Both add land to the park which would be landscaped and provide pedestrian connections. T Modified has similar effects on highway landscaping, converting a larger net area to pavement and adding less new landscaped land to the park.

Designated Parks. The MDC has recently acquired the GSA site in Cambridge and Boston on the north side of the Charles River and will shortly take possession of riverfront land along Nashua Street opposite the new Suffolk County Jail. Both parcels will be developed for park use. Option 5A Modified would severely impact the Nashua Street parcel with boat section ramps. The other schemes would have no direct long-term impacts on this land. There would be no direct long-term impacts by any scheme on the GSA site. All schemes would have some visual impact, although not of such a magnitude as to impair park use. S Modified would have greater visual impact on the GSA site than 5A Modified and T modified, and Z Modified would have the greatest visual impact.

Table 1.18

OPEN SPACE AND PARKLAND
SUMMARY OF LONG-TERM IMPACTS BY OPTION

Open Space Area		5A Modified	S Modified	T Modified	Z Modified
1	Designated MDC Nashua Street Parkland	Parkland development precluded by tunnel and boat ramps	No direct impact	Temporary impacts only	No direct impact
2a	MBTA trestle, west	Riverside tunnel would occupy space	No direct impact	No direct impact	No direct impact
2b	MBTA trestle, east walkway	Riverside tunnel would occupy space	240 feet of 655-foot walkway between/under bridges	130 feet of 655-foot walkway under bridge	300 feet of 655-foot walkway under bridges
3a	Paul Revere Landing Park, south bank	0.9 acre of park used	0.8 acre of park used, 73 parking spaces removed	0.77 acre of park used, 73 parking spaces removed	0.69 acre of park used, 73 parking spaces removed
3b	Charles River Dam walkway	Bridge would pass over walkway casting shadows and diminishing environmental quality	Bridge would be west of dam and dominate upstream views	Bridge would be west of dam and dominate upstream views	Bridge would be west of dam and dominate upstream views
3c	Paul Revere Landing Park, north bank	Bridge would pass over corner of park and dominate views	Bridge would be 320 feet west of park, accommodates park expansion	Bridge would be 330 feet west of park, accommodates park expansion	Bridge would be 300 feet west of park, accommodates park expansion
4	MDC proposed walkways to Causeway Street	Access improved on east side, accommodated on west side of I-93. Pedestrian conflicts at ramps to Causeway Street	Access improved on east side, walkway cannot be built on west side of I-93. Pedestrian conflicts at ramps to Causeway Street	Access improved on east side, walkway cannot be built on west side of I-93. Pedestrian conflicts at ramps to Causeway Street	Access improved on east side, secondary access on west side of I-93, new park to be developed on Causeway Street; no ramps to Causeway Street, thus pedestrian environment improved

Table 1.18 (Cont.)

OPEN SPACE AND PARKLAND SUMMARY OF LONG-TERM IMPACTS BY OPTION

pen Space Area	5A Modified	S Modified	T Modified	Z Modified
MDC proposed Lovejoy Wharf walkway	Part of Charles River Building taken, ventilation building on site, walkway and ferry terminal provided by project	Walkway and ferry terminal provided by project	Walkway and ferry terminal provided by project	Walkway and ferry terminal provided by project
Proposed CANA Landscape improvements				
a. Highway Infield Area	Landscaped, some areas shaded	Landscaped, some areas shaded	Landscaped, some areas shaded	Landscaped, some areas shaded
b. Bank of Charles River	Landscaped, two 110-foot sections under bridges	Landscaped, 400 feet under bridges	Landscaped, 350 feet under bridges	Landscaped, 430 feet under bridges; 300 feet under high ramp admitting sunlight sufficient for landscaping
c. Pedestrian Bridge at railroad	No conflict	No conflict	No conflict	No conflict
d. Path from Rutherford Avenue	Landscaped, portions under viaduct, ramps	Largely under viaducts and ramps; relocation desirable	Largely under viaduct and ramps; relocation desirable	Largely under viaduct and ramps; relocation desirable
e. Reconstruction of Millers River	Elevated structure nearby	Under highway structure; relocation may be possible.	Largely under highture; relocation may be possible.	Under highway structure; relocation may be possible.
f. Paul Revere Park Expansion	Not possible	Expanded substantially	Expanded substantially	Expanded substantially
7 Proposed North Point Waterfront	Potentially improved as parkland, some visual impact	Potentially improsed as parkland, greater visual impact from loop ramps	Potentially improved as parkland, some visual impact	Potentially improved as parkland, greater visual impact from loop ramps

Table 1.18 (Cont.)

OPEN SPACE AND PARKLAND
SUMMARY OF LONG-TERM IMPACTS BY OPTION

Open Space Area	5A Modified	S Modified	T Modified	Z Modified
8 Proposed MDC Parkland on former GSA property	Least visual impact	Some visual impact	Least visual impact	Greatest visual impact
9 Charles River	Two bridges each approximately 100 feet wide cast shadows	Bridges approximately 300 feet wide cast shadows	Bridges approximately 240 feet wide cast shadows	Bridges approximately 340 feet wide cast shadows
10 Leverett Circle/ Storrow Drive/ Esplanade	Temporary and small permanent use of land from Esplanade (MDC parking lot) for highway	Net change of 0.3 acre from existing highway landscaping to pavement; 0.27 acre of new landscaping and pedestrian access improvements added	Net change of 0.58 acre from existing highway landscaping to pavement; 0.18 acre of new landscaping and pedestrian access improvements added	Net change of 0.3 acre from existing highway landscaping to pavement; 0.27 acre of new landscaping and pedestrian access improvements added

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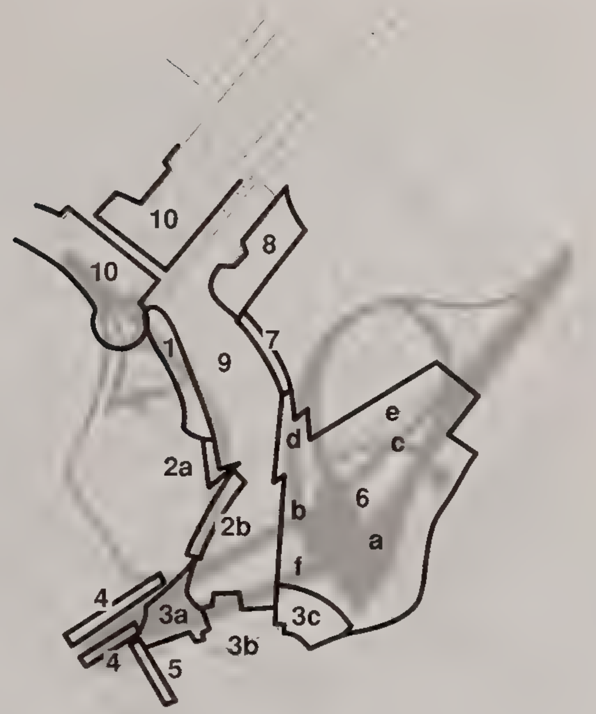
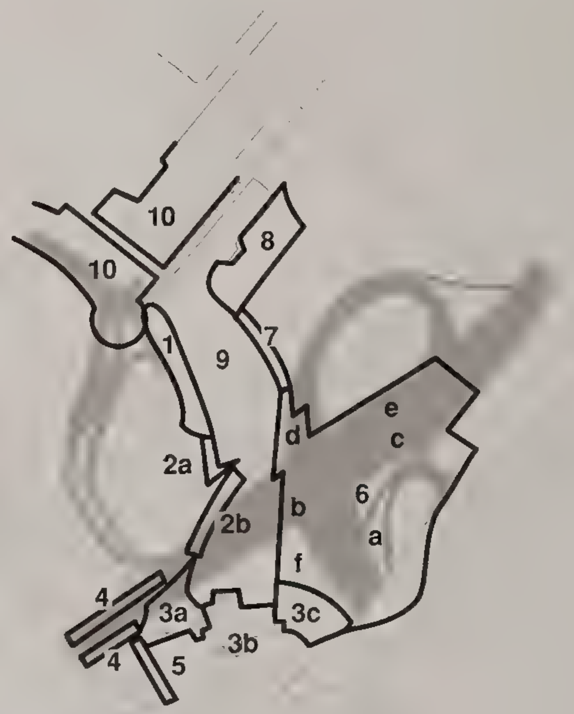
1. See Figure 1.4 for location of open space areas and Table 1.24 for construction period impacts

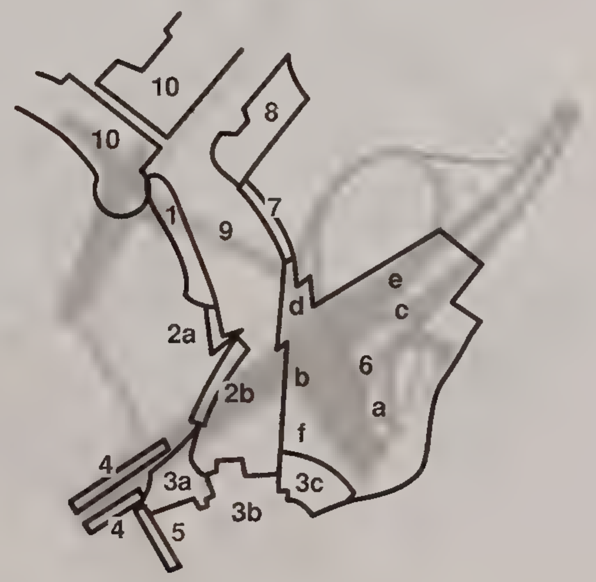
Source: Bechtel/Parsons Brinkerhoff



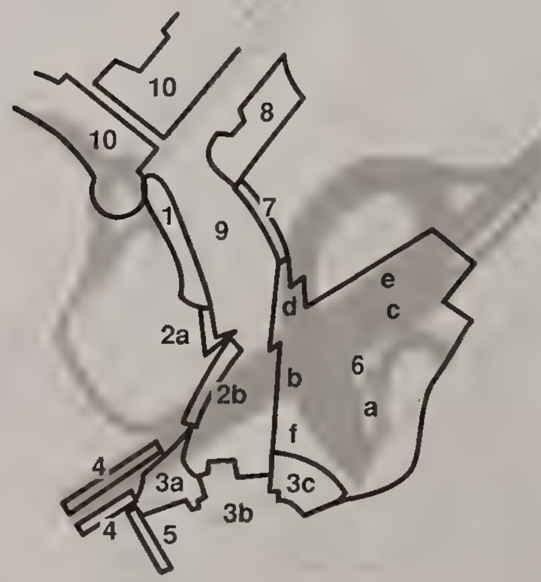
5A Modified



S Modified



T Modified



Z Modified

LEGEND

1 Nashua Street Parkland
2 Walkways To MBTA Trestle
3 Paul Revere Landing Park
4 Proposed Walkways To Causeway Street
5 Lovejoy Wharf
6 Proposed CANA Improvements
  a Highway Infield Areas
  b Bank Of Charles River
  c Pedestrian Bridge Over Railroad
  d Path From Rutherford Avenue
  e Reconstruction Of Millers River
  f Expanded Paul Revere Landing Park
7 North Point Waterfront
8 Proposed MDC Parkland
9 Charles River
10 Leverett Circle/ Storrow Drive/Esplanade

FIGURE 1.14

Impacts To Existing And Proposed Open Space For 5A Modified, S Modified, T Modified, And Z Modified

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0 400 800 Feet
200 300

Proposed Park Improvements. Local access ramps in 5A Modified, S Modified and T Modified would present conflicts with pedestrian access improvements from Causeway Street to the Paul Revere Landing Park; Z Modified has no such conflicts and provides more land for pedestrian access from Causeway Street. Access to the open space system can be improved via development of Lovejoy Wharf as a walkway in all schemes, although 5A Modified would locate a ventilation building on or adjacent to the wharf. Lovejoy Wharf is currently in private ownership, and one-half of it is used for parking; the other half is dilapidated.

The CANA parkland improvements, to which the Department has committed as described above, would be affected to different degrees by the four schemes. Option 5A Modified would require the least revision from the CANA landscaping plan for the area; however, part of the Paul Revere Landing Park CANA replacement land would be under the northbound I-93 bridge. The three other schemes all allow the usable area of this portion of the park to be almost doubled.

1.4.8 Visual Impacts

Vantage Points And Criteria For Visual Evaluation. The Charles River crossing schemes would differ in appearance from different vantage points and as perceived by resident and transient observers, i.e., those who experience the area from one location versus those who pass through it. For example, the bridges in any scheme would be a smaller part of the visual experience of the Charles River area for a recreational cyclist on a 5-mile circuit than for the user of a single park site near the bridges.

Schemes 5A Modified, T Modified, and Z Modified are illustrated on the following pages, using models constructed at 1"=40' scale and existing site photographs matching the locations of the model photos as closely as possible. It should be noted that small differences in vantage point can alter the way a complex highway interchange appears in photographs, and that the small number of views and limitations in model construction and photography make it possible to give only a general portrayal of how the schemes would look if built. Scheme S Modified is discussed in comparison to schemes T Modified and Z Modified, parts of which it resembles from different vantage points.

The visual characteristics of the schemes are first discussed below with reference to aerial views of scale models. The schemes are then described and compared to each other and to existing conditions from four viewpoints as they would be seen by pedestrians:

- Science Park station at Leverett Circle
- The North Point site on the Cambridge waterfront
- The edge of the Charlestown residential community at Rutherford Avenue
- Paul Revere Landing Park on the north bank of the Charles River

The evaluations make reference to five types of visual evaluation criteria:

- Visual continuity: the extent to which familiar views are enclosed or restricted, important site lines maintained, or less of the river's surface left open to view.

- Scale of structure: the comparative size of the visible portion of the project in relation to other familiar features in the landscape, such as the Green Line viaduct, railroad bridge, or Spaulding Hospital.

- Density of structure: the degree to which the structure is partially open, admitting views beyond and maintaining visual continuity.

- Shadow effects: the extent to which the structure casts shadows on the Charles and Millers Rivers, important pedestrian paths, and development sites.

- Pedestrian environment: the extent to which the project becomes the dominant element in the experience of the pedestrian, resident, or park user, based on proximity, shadows, overhead elements, and sufficient visibility for safety.

S Modified would cover a larger portion of the CANA improvement area than 5A Modified and T Modified, including the Charles River bank, Millers River, path from New Rutherford Avenue, and highway infield areas. T Modified would also cover more area than 5A Modified, but less than S Modified and Z Modified. Z Modified would cover the largest area. The important pedestrian path over the railroad tracks and along the Charles River could be accomplished in all schemes, but amenity would be limited to the degree it was covered by structure. The path from New Rutherford Avenue would be largely under highway structure in options S Modified, T Modified, and Z Modified and partially under structure in 5A Modified and should probably be relocated. The Millers River would be largely under highway structure in S Modified and Z Modified and partially covered in T Modified, making plant growth difficult; relocation of the river may be possible.

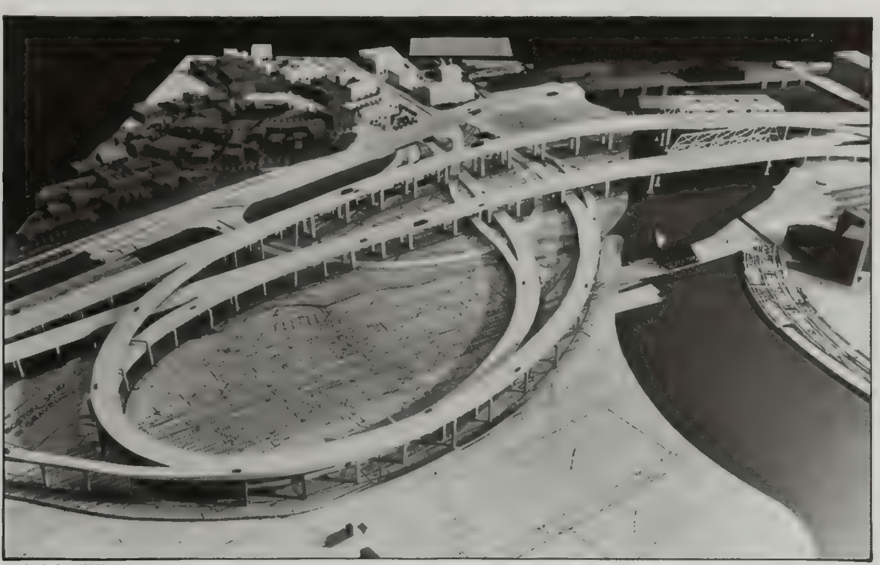
The river frontage of the North Point site has been discussed as a site for park improvement. Because of its proximity to the project's loop ramps, there would be some visual impact in all schemes, although not of sufficient magnitude to preclude park use. The visual impact would be greatest in scheme Z and least in schemes 5A Modified and T Modified, as described in Section 1.4.8.

Other Areas. There would be some visual impact on the MBTA-owned walkways on either side of the railroad trestle on the south side of the Charles River.

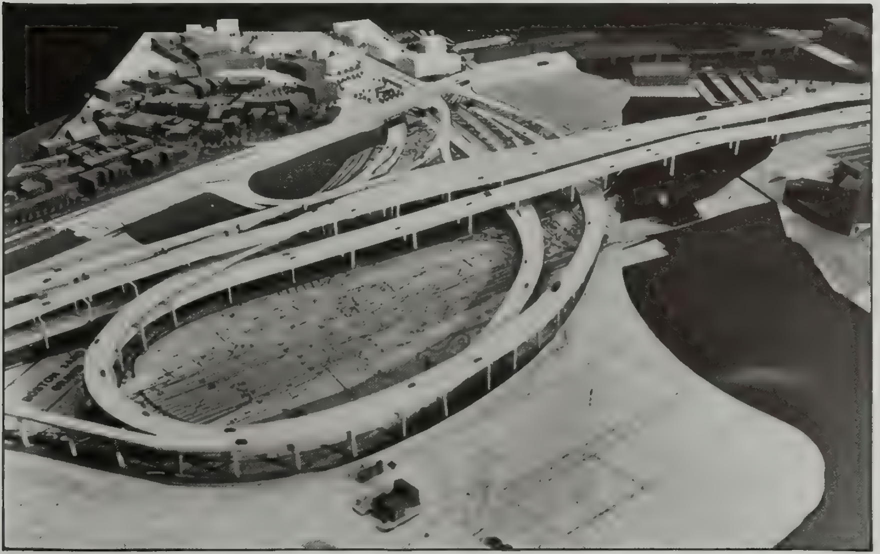
Overall Visual Characteristics Of Schemes. Figures 1.15 and 1.16 show aerial views of scale models of three of the four schemes.

Option 5A Modified: This includes two bridges, separated to avoid the existing I-93 bridge during construction; the FEIS/R showed these bridges with overhead trusses, although another bridge type would also be possible. Each bridge would taper from approximately 110 to 90 feet wide, making them slightly more dense in appearance than the existing bridge. The western (upstream) bridge would be 320 feet from the railroad bridge near the north bank. The eastern (downstream) bridge would be 100 feet from the Charles River dam pumphouse, crossing above the walkway over the locks of the dam and a corner of the north bank portion of Paul Revere Landing Park. The two new bridges and railroad bridge cut the river into four small segments surrounded by transportation structures. The CANA loop ramps extend into Cambridge bounding the North Point development site and then turning to run parallel to the Charles River bank, where future pedestrian paths will be created after completion of the Artery/Tunnel Project.

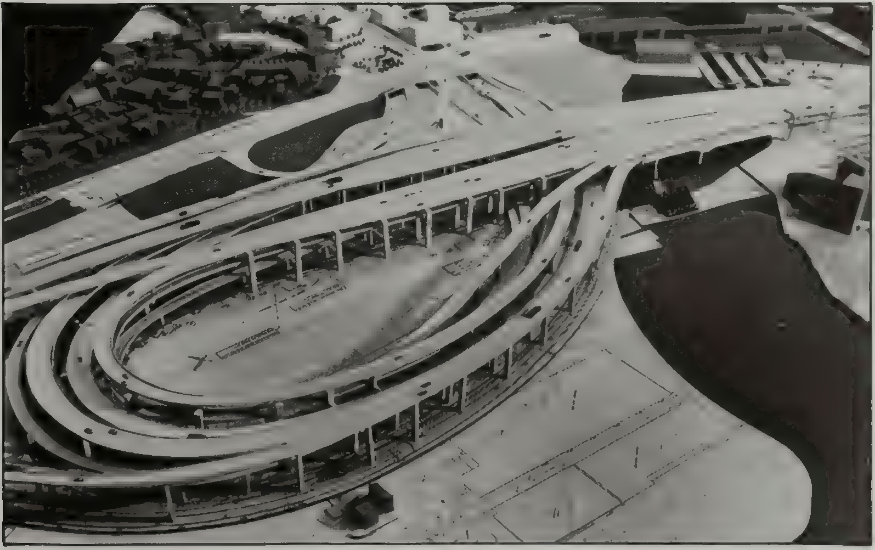
Open boat section ramps would occur in the river near the Nashua Street parcel designated for parkland, and surface roadways would make this parcel largely unusable for designated



5A Modified



T Modified

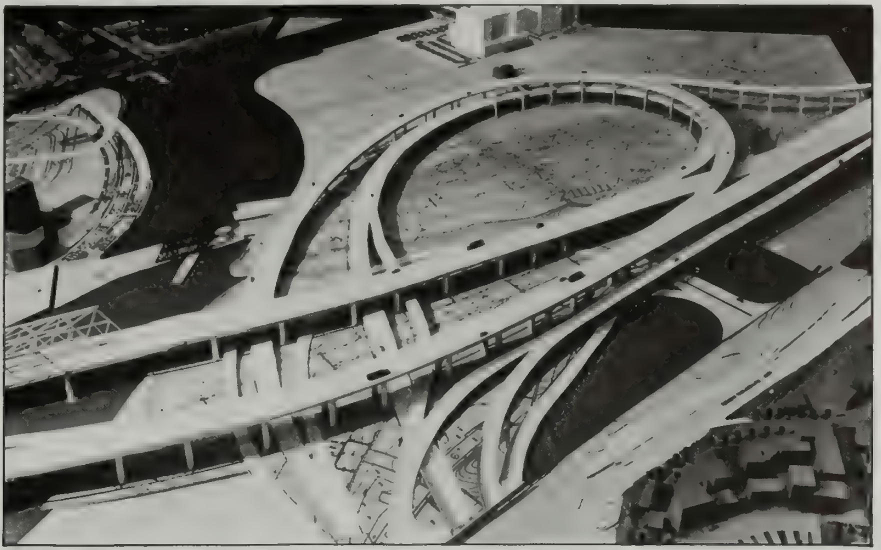


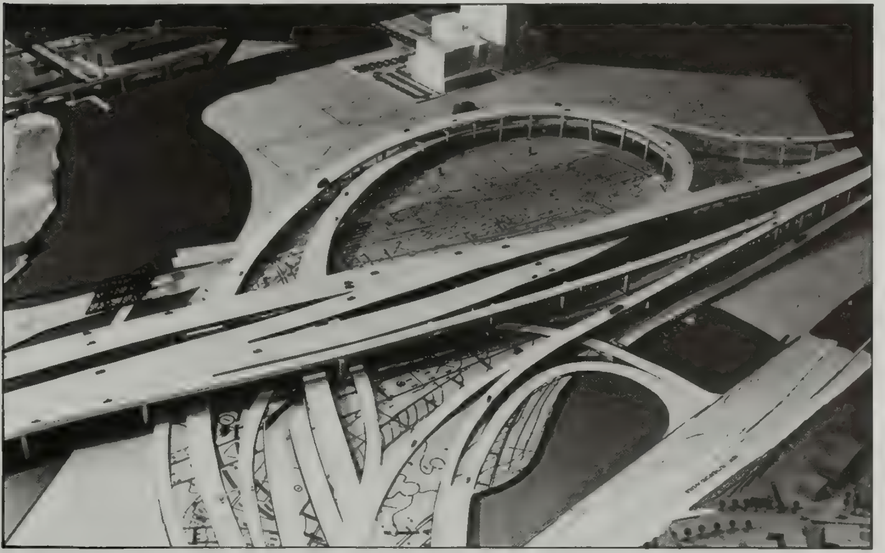
Z Modified

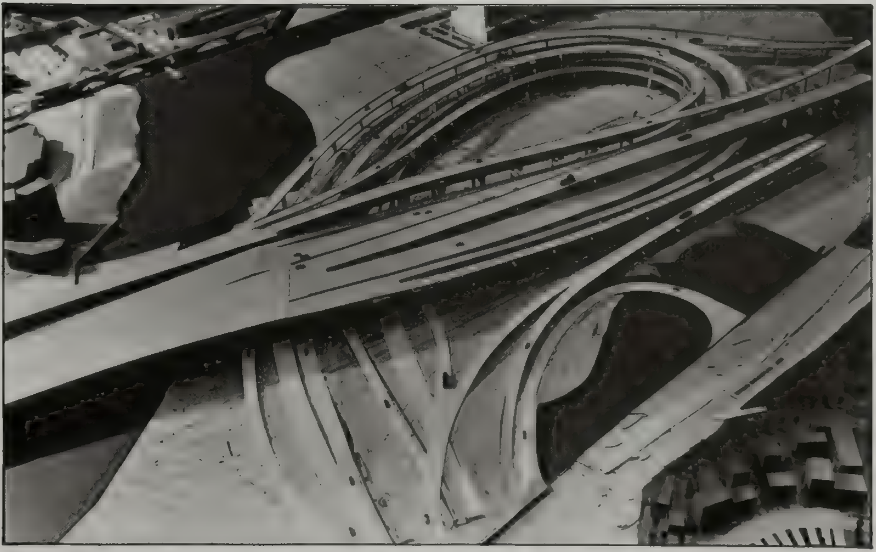
FIGURE

1.15 **Aerial View Of I-93/Route 1 Interchange By Option, Looking East**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R


5A Modified


T Modified


Z Modified

FIGURE

1.16 **Aerial View Of I-93/Route 1 Interchange By Option, Looking West**

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

park use. A ventilation building would be located on Lovejoy Wharf, taking part of the Charles River building. (As noted elsewhere in this chapter, 5A Modified, designed prior to 1985, would also conflict with the recently completed Suffolk County Jail.)

Option T Modified: This would have two bridges side-by-side and located further upstream, 180 feet from the railroad bridge near the north bank. These bridges would be approximately 210 feet wide at the north riverbank. They would cross the bank at an angle, covering a 360-foot segment of future riverfront pedestrian path. The bridges would be 400 feet from the Charles River dam and the north bank of the Paul Revere Landing Park. (Compared to 5A Modified, T Modified and the other more recent schemes, they would increase the usable space near the Charles River dam and Paul Revere Landing Park, and reduce the less desirable area sandwiched between the highway and railroad bridges.)

Loop ramps would be shifted approximately 25 feet further west into Cambridge than in 5A Modified, but the size and density of the ramps would be similar. The land between the ramps and the riverbank faces south and would receive afternoon sun.

Tunnel connections to Storrow Drive would temporarily disrupt use of the Nashua Street riverfront parcel during construction. Ventilation buildings on each side of the river would be required. Both would be visible but not dominant elements of the landscape around the river.

Option Z Modified: This would have three closely spaced bridges, one of them double-decked. They would be located 80 feet from the railroad bridge near the north bank and 380 feet from the Charles River dam. The bridges would have a total width of 340 feet at the north riverbank, which they would cross at an angle, covering a 430-foot segment of future riverfront pedestrian path. Option Z Modified would shade more of the future path on the north riverbank than the other schemes. The Millers River would be completely shaded.

There would be more loop ramps than in 5A Modified or T Modified, and they would be higher and extend 85 feet further into Cambridge than 5A Modified and would appear more dense. The outer ramp would be tangent to the riverbank, covering an additional 300 feet of riverfront. Sunlight would reach under this ramp in the afternoon. There would be no tunnels north of Causeway Street requiring ventilation buildings, and there would be no elements on or near the Nashua Street parkland parcel. The absence of Causeway Street ramps would improve the pedestrian environment there.

Option S Modified: This option (not shown in figures) would have bridges similar to Z Modified, but narrower and with greater separation of the double-decked bridge; the total distance covered or bounded by these bridges would be 300 feet. The western (upstream) double-decked bridge would extend to within 100 feet of the railroad bridge near the north bank, and the eastern (downstream) bridge would be 400 feet from the Charles River dam pumphouse, reducing visual impacts on Paul Revere Landing Park and the walkways on the dam. There would be more loop ramps than in 5A Modified, but less than Z Modified. The Millers River would be largely shaded. A ventilation building would be located on the Boston Thermal site.

Looking East (Downstream) From The Leverett Circle Area. From the Science Park MBTA station the expanse of river's surface will be visible, edged by low warehouse buildings in

Cambridge, with the double-decked I-93 viaduct and bridge partially screening and enclosing the view toward Charlestown. The Spaulding Hospital, new Suffolk County Jail, and railroad bridge are the largest objects within the near view, with the Bunker Hill monument and Boston Sand & Gravel elevator rising in the background (see Figure 1.17).

Option 5A Modified: This option would cross the river 320 feet further upstream and be lower than the existing I-93 bridge. Its single-deck bridges carrying northbound and southbound movements would be separated, allowing one to see through the bridge piers to the other side. The CANA loop ramps would be dominant elements comparable in height to other features of the landscape but substantially larger in breadth. Although it would be possible to see through the loop ramps to the I-93 mainline viaducts and Charlestown, the overall effect would be of a wall enclosing the Lower Charles River.

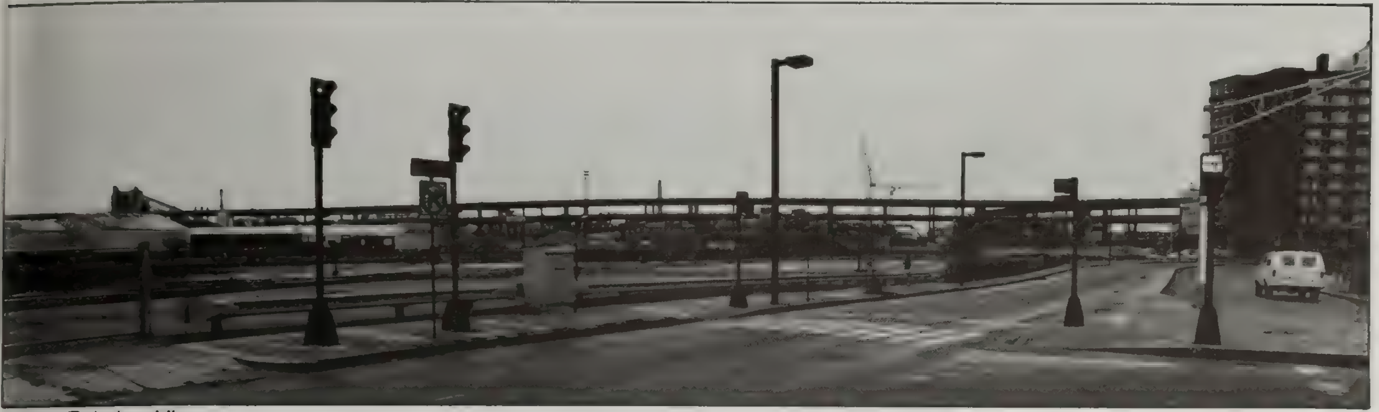
Option 5A Modified would also have two large open boat-section ramps in the foreground of this view, one located in the Charles River, the other crossing the Nashua Street parkland parcel toward the viewer along with a surface roadway. These features would appear even more severe from ground level, with low walls cutting off the pedestrian from access to the river.

Option T Modified: This option has side-by-side bridges across the Charles River located 400 feet closer to this viewpoint than the existing bridge. The total width of bridge structure will be approximately 240 feet (from upstream to downstream edge). It would be possible to see under these bridges, between the bridge piers to the new dam. The bridge decks would be approximately the same height as in 5A Modified, but the northbound viaduct would rise higher than in 5A Modified and be visible beyond the loop ramps. The loop ramps would be similar in height and location to those of 5A Modified, so that differences in scale of the visual barrier would be difficult to discern, but overall density would be greater, due to a wider structure beyond the loop ramps. Following tunnel construction across the river to Leverett Circle, there would be no permanent disruption to the planned Nashua Street parkland in the foreground.

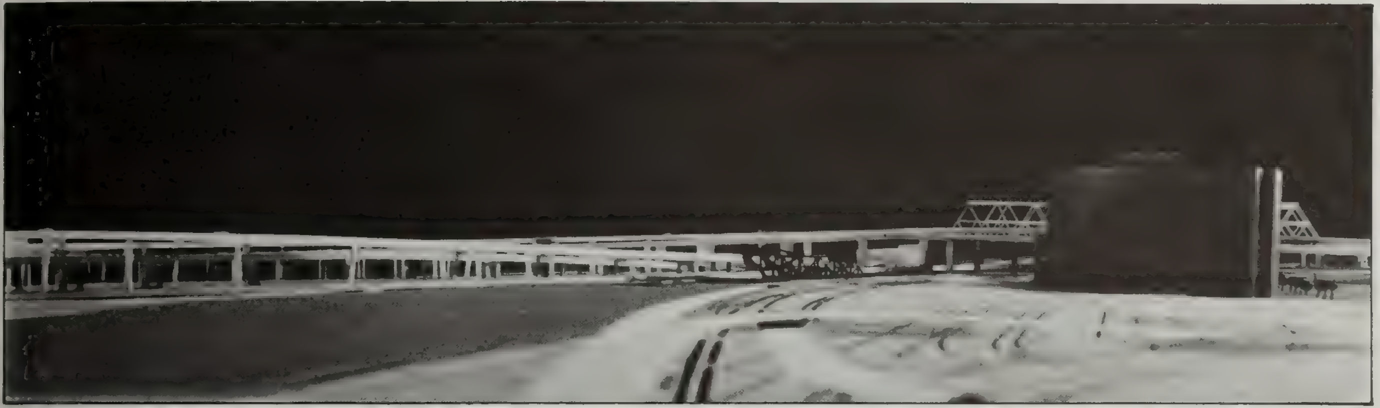
Option Z Modified: Option Z Modified would be 500 feet farther upstream than the existing bridge, the upstream bridge double-decked, and the total width of bridge structure approximately 340 feet (from upstream to downstream edge). It would be possible to see under these bridges, between the bridge piers to the new dam. The loop ramps would be closer to this vantage point than in 5A Modified, and both the outside loop ramp and the northbound I-93 mainline would be higher than in the other schemes. The visual barrier enclosing the Lower Charles River would be closer and appear larger and more dense from this point of view than in the other schemes. There would be no direct effect on the planned Nashua Street parkland in the foreground.

Option S Modified: (not shown) would have bridges similar in appearance to Z Modified from this viewpoint. S Modified's outer loop ramp would be between Z Modified and T Modified in height and location and the density of the visual barrier created would be between that of Z Modified and T Modified.

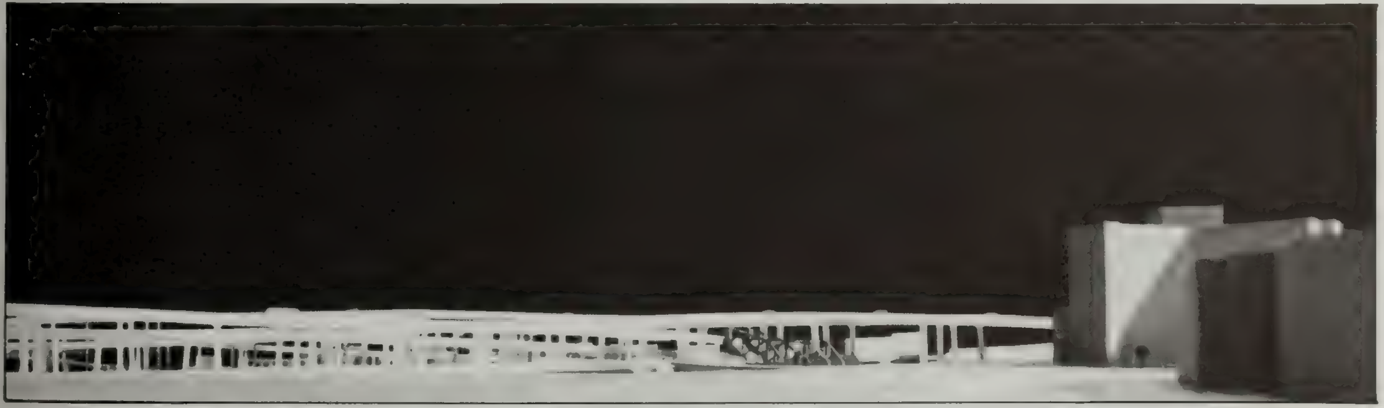
Summary: In all options the highway elements will be of such a scale as to diminish currently dominant features in this view, and will create a nearby visual barrier enclosing the Lower Charles River and further obscuring downstream views which are currently partly



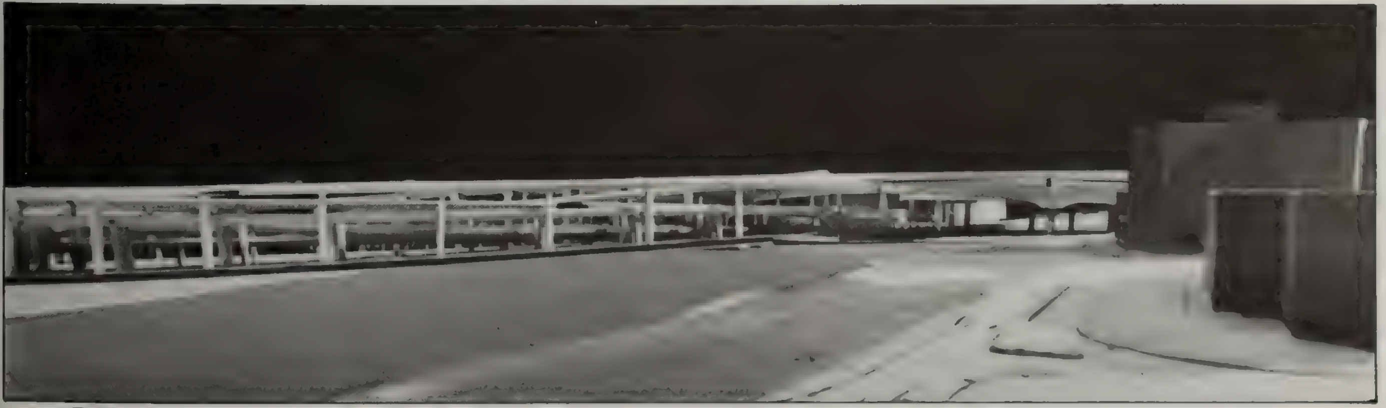
Existing View



5A Modified



T Modified



Z Modified

FIGURE 1.17 **Views Of I-93/Route 1 Interchange By Option, Looking East From Science Park Station**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

screened by I-93. Z Modified would have a marginally greater impact than the other options, followed by S Modified, T Modified, and 5A Modified.

Looking East (Downstream) From The Cambridge Waterfront. Views from this area today consist of existing warehouse buildings set close to the river's edge; they will be replaced by mixed use development and a waterfront park. Beyond them the Spaulding Hospital, railroad bridge, existing high-level bridge (I-93), and, beyond it, the new dam and North Washington Street bridge can be seen. [Model photographs are from the North Point site. The existing site photograph was taken from further upstream and closer to the river (see Figure 1.18).]

Option 5A Modified: Bridges would be clearly visible above the MBTA railroad trestle, similar to the existing I-93 bridge. The CANA loop ramps would be close to the edge of the river, appearing larger in scale than other objects in the landscape and dominating the downstream view. From this viewpoint, it will be possible to see the underside of the loop ramps, the infield area within the loop ramps, and down the riverbank to the North Washington Street bridge, beyond the new bridges. The prominence of the loop ramps would depend on the extent to which development which occurs in the North Point area and the park created along the river's edge are able to screen them from view and provide visual interest in the foreground. However, the overhead decks of the loop ramps and bridges would increasingly dominate the pedestrian's view downstream toward the pedestrian overpass (not in model) to be constructed over the railroad tracks. Pedestrians would then pass through the two relatively short segments of riverbank defined by the railroad and highway bridges, separated by relatively short (110-foot) segments shadowed by the two bridges.

Option T Modified: T Modified would be similar in appearance to 5A Modified from this viewpoint until approaching the bridges close enough to see the wider, parallel bridge decks, rather than the separated bridges of 5A Modified. Overhead decks of the loop ramps and bridges would increasingly dominate the pedestrian's view as one moves downstream toward the pedestrian overpass (not in model) at the railroad tracks. Pedestrians then would pass through a narrow segment of riverbank defined by the railroad and highway bridges, and under the bridges for a distance of 360 feet, emerging into a longer segment of usable area near the dam. A ventilation building would be visible just inside the outer loop ramp immediately east of the MBTA tracks.

Option Z Modified: Bridges over the Charles River would be higher, because of the double-deck bridge closest to this viewpoint, and would be physically wider than in the other schemes (340 feet between upstream and downstream edges). Loop ramps would extend further upstream and would become tangent to the river beyond the railroad tracks rather than set back from it. The outer loop ramp would be higher than in other options, and a pedestrian at the river's edge would perceive the ramp decks as being overhead from points further upstream. However, the height of the ramp would also admit sunlight and make it less obtrusive when facing the river or moving upstream. The pedestrian would see the dam and the North Washington Street bridge underneath the new I-93 bridges, but the length of path under ramps or bridges would be greater than in other schemes -- 730 feet. Near the bridges, sunlight would reach the riverbank and penetrate under the outer ramps during the afternoon; more of this area would be in morning shadow than in the other schemes owing to the double-decked bridge. Morning shadows would also extend further into the northern half of the North Point development area.

Option S Modified: This option (not shown) would have an appearance between that of Z Modified and T Modified from this viewpoint, with the main difference being that its outer loop ramp would be lower than that of scheme Z Modified and set back farther from the river bank.

Summary: The bridges and loop ramps would be the largest elements in downstream views from this area, with Z Modified being noticeably higher and closer than T Modified and 5A Modified. In all schemes the visual continuity of the river's surface would be unchanged.

Looking West (Upstream) From Paul Revere Landing Park, North Bank. The existing view from this area is dominated by the I-93 bridge piers and decks, which are high overhead. One can see the railroad bridge, Science Museum, and Green Line viaduct upstream between the bridge piers. (The existing site photograph was taken from further upstream than the model photos, whose vantage point is within the park, northeast of the dam pumphouse.) Proposed buildings on O'Brien Highway near the Lechmere MBTA station in Cambridge provide a reference point near the center of the model photos (see Figure 1.19).

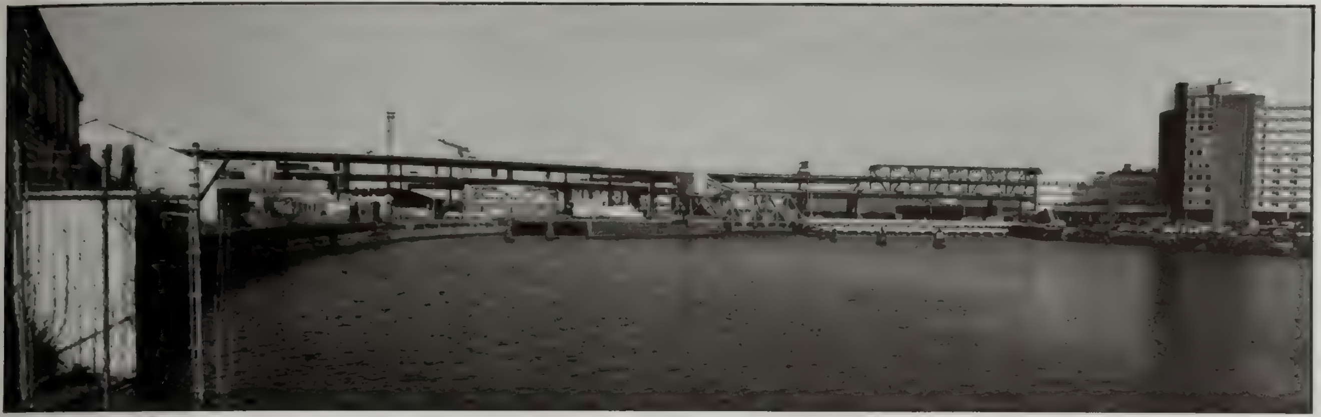
Option 5A Modified: A northbound bridge would extend 100 feet downstream of the existing I-93 bridge, becoming a much more intrusive feature of the landscape and casting afternoon shadows on the park. One could see upstream through the bridge piers to the railroad bridge and the arches of the Green Line viaduct, maintaining some visual continuity to the area between the dams, and making a destination visible to pedestrians headed toward the Science Museum dam via the path to be constructed along the river. The usable space between the North Washington Street bridge and the new I-93 bridge would be reduced.

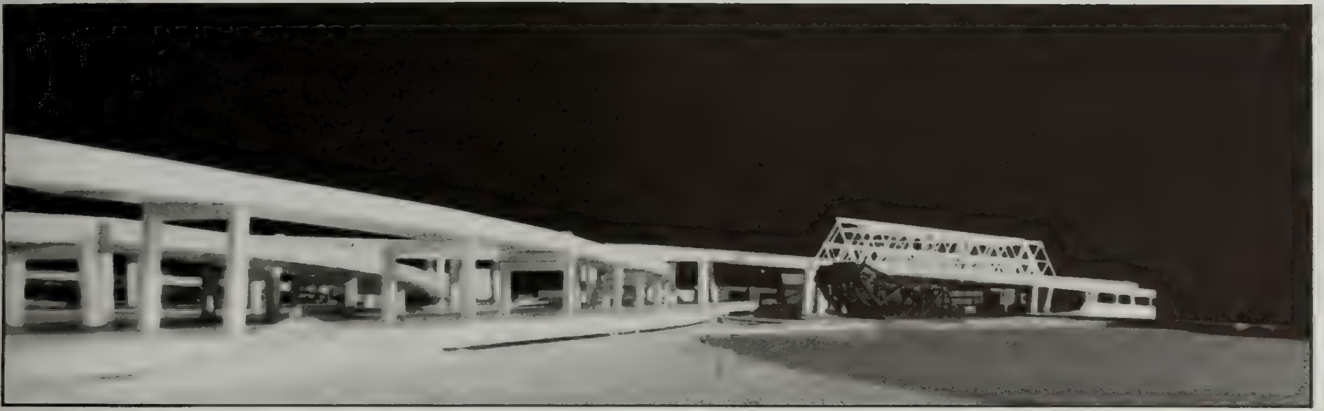
Option T Modified: A bridge would be located 400 feet upstream of the dam's pumphouse and would permit views between the bridge piers to the railroad bridge and Green Line viaduct. Although the 360-foot length of riverbank under the bridges would be in shadow, pedestrians headed toward the old dam near the Science Museum via the path to be constructed along the river would be able to see their destination. The visual environment of Paul Revere Landing Park would be substantially improved by the creation of a larger usable space in the foreground. Shadow impacts would be reduced compared to 5A Modified.

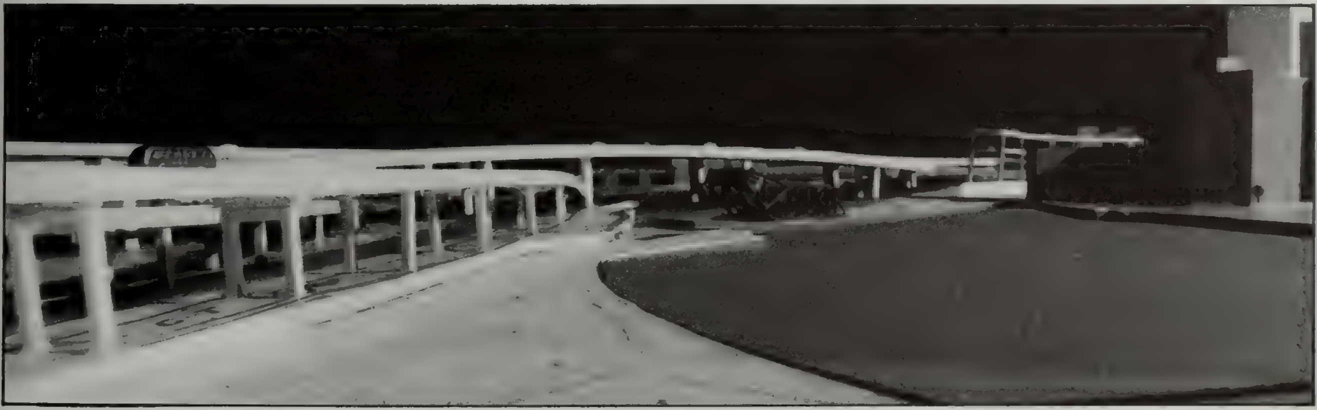
Option Z Modified: A bridge would be located 380 feet upstream of the dam's pumphouse and would permit views between the bridge piers to the railroad bridge and the arches of the Green Line viaduct. Although the 430-foot segment of path under the bridges would be in shadow, pedestrians headed toward the Science Museum dam via the path to be constructed along the river would be able to see their destination beyond. As in schemes T Modified and S Modified, the visual environment of Paul Revere Landing Park would be substantially improved by the creation of a larger usable space in the foreground. Shadow impacts would be reduced compared to 5A Modified.

Option S Modified: This option (not shown) would be very similar to Z Modified from this viewpoint, owing to the similarity in bridge location and width.

Summary: Options S Modified, T Modified, and Z Modified would all substantially improve the visual environment of Paul Revere Landing Park and the river segment immediately upstream of the dam, compared to 5A Modified. In all options (and the existing condition), one would be able to see the underside of bridge decks from the park, and bridge piers would disturb the visual continuity of the river's surface to differing extents.


Existing View


5A Modified


T Modified

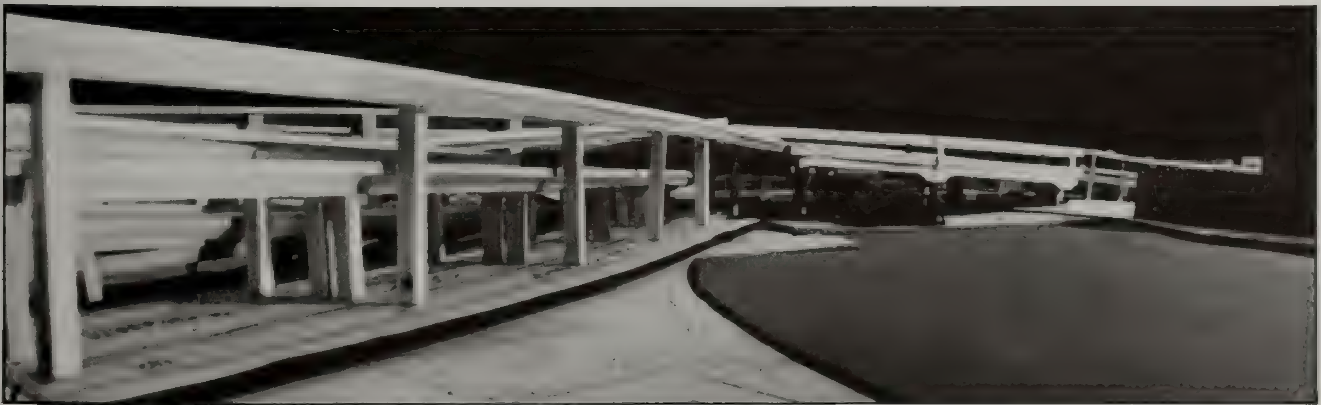
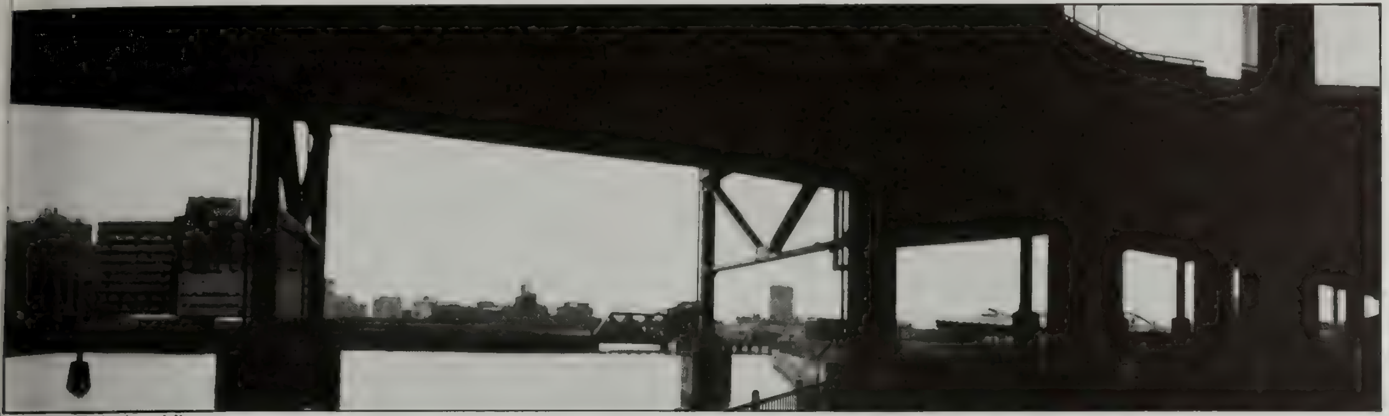

Z Modified

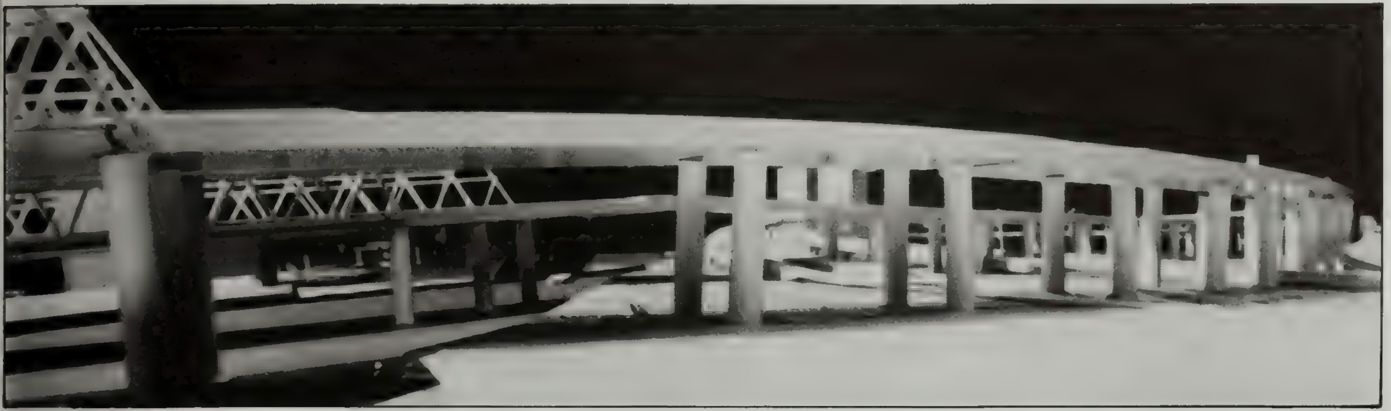
FIGURE
1.18

Views Of I-93/Route 1 Interchange By Option, Looking East From North Point Area, Cambridge

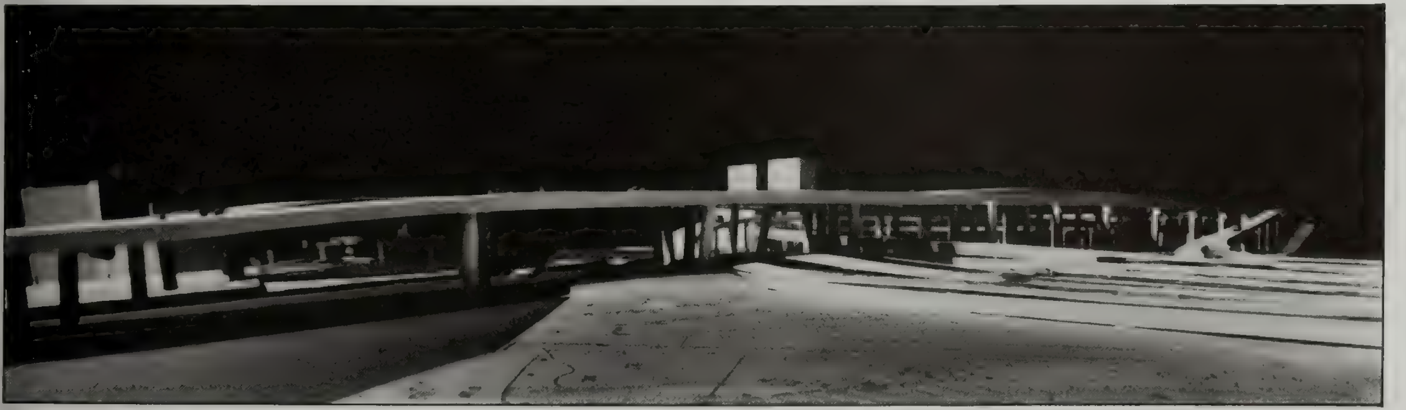
THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R



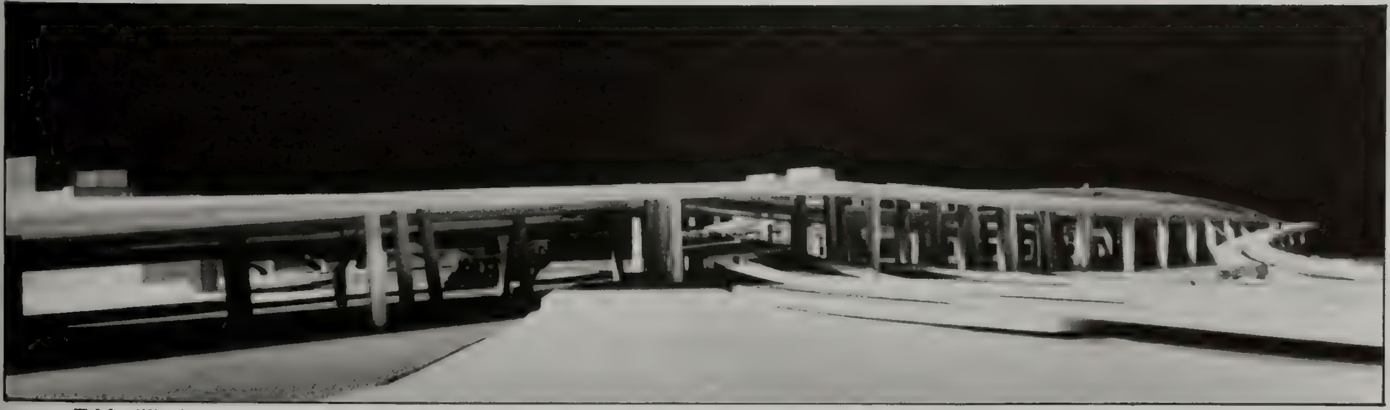
Existing View



5A Modified



T Modified



Z Modified

FIGURE 1.19

Views Of I-93/Route 1 Interchange By Option, Looking West From Paul Revere Landing Park, North Bank

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Views from the walkway on the new dam would be very similar to those just described from the north bank viewpoint.

Looking Southwest From The Rutherford Avenue Edge Of Charlestown. Existing views from this area, and from the upper floors of Charlestown residences, are of the double decked I-93 viaduct with the Boston skyline partially visible beyond. [Photographs were taken from approximately 600 feet south of Austin Street (see Figure 1.20).]

Option 5A Modified: 5A Modified would result in a visual screen which would move approximately 100 feet closer to the residential community. The ramp rising from left to right in the photograph would make the structure appear larger and more dense.

Option T Modified: This option would have its closest ramps in a similar location to those of 5A Modified. Additional viaducts would be added in the background, making the structure more dense and difficult to see through.

Option Z Modified: This option would have its nearest ramps approximately 50 feet farther away than those of 5A Modified from the residential area in the foreground of the photograph and nearly 300 feet further away from City Square. However, additional ramps in the background would increase the height and density of the visual screen.

Option S Modified: This option (not shown) would be between Z Modified and T Modified in location, height, and density.

Summary: In all schemes, the new viaducts would appear similar but denser than those of existing I-93 in this area. A proposed pedestrian path from Rutherford Avenue through the highway area to the Charles River would have to pass between columns and under highway decks, restricting sight lines and making landscaping increasingly difficult in options 5A Modified, T Modified, S Modified, and Z Modified.

1.4.9 Relocation Impacts

The relocation impacts of the options vary as a result of differences in roadway alignment, ventilation requirements and construction methods. (The relocation impacts of each option are noted in Table 1.19 and shown in Figure 1.21.)

Any business fully or partially taken by the project would be entitled to relocation assistance benefits. The Department would work with the affected business to relocate the activity on the same site or elsewhere, and a Relocation Plan would be prepared. All options would require the relocation of parking on Lovejoy Wharf, the parking lot behind Boston Garden owned previously by the North Station Auto Park Corporation and the Anelex Building. What follows is a summary of the distinct relocation impacts on private businesses in the affected area.

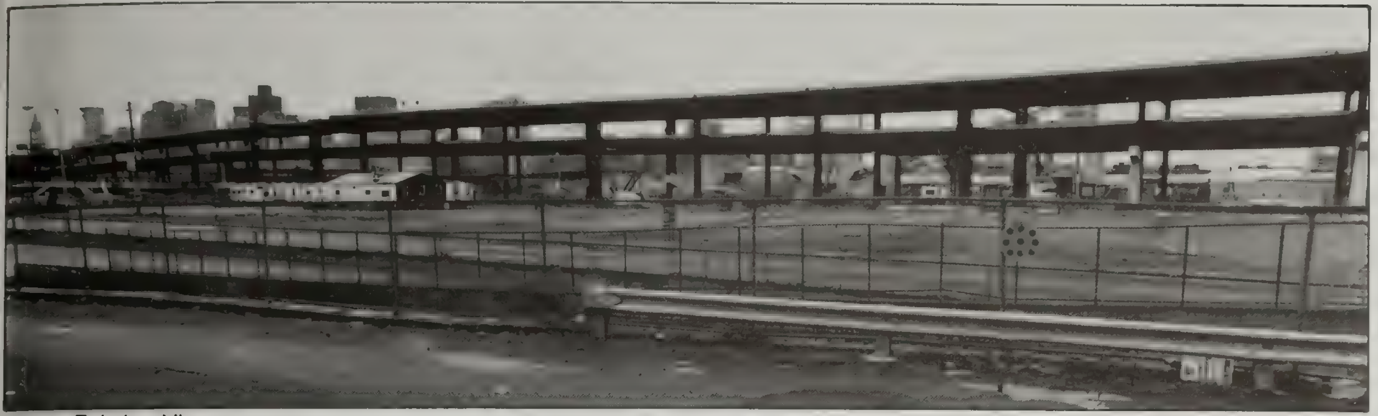
Option 5A Modified. In this option, the alignment of the roadway would result in impacts to the Charles River Building (100-foot bay taken). The garage of the Boston Sand & Gravel facility and the loading dock of the Stop & Shop Building would be taken, but no relocations are required as a result.

Table 1.19

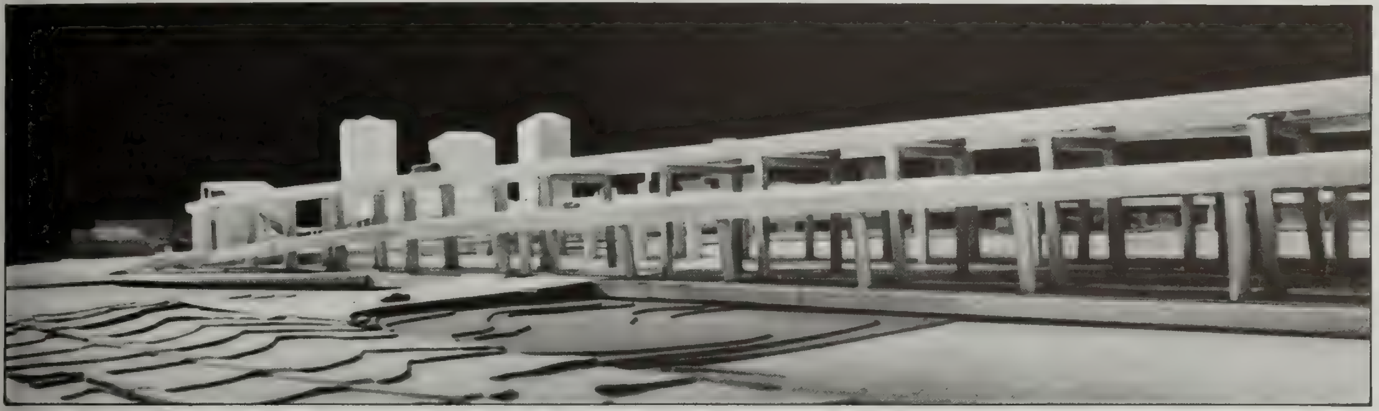
RELOCATIONS REQUIRED IN THE AREA NORTH OF CAUSEWAY STREET

Impact	5A Modified	S Modified	T Modified	Z Modified
Boston Sand & Gravel	Minor impact, garage affected	Full or major partial taking	Partial taking	Full or major partial taking
Charles River Building	100-foot bay of the building taken	Loading dock taken, no relocation necessary	Loading dock taken, no relocation necessary	Loading dock taken, no relocation necessary
Stop & Shop Building	Loading dock taken	No impact	No impacts	No impact
Boston Thermal Corporation	No impact	Taken	Taken	Temporary taking of ice annex; no relocation necessary
B&M North Terminal (Warehouse)	No impact impact	Possible major	Taken impact	Possible major
Lovejoy Wharf (private parking)	Parking to be relocated	Parking to be relocated	Parking to be relocated	Parking to be relocated
North Station Auto Park Corp.	Taken	Taken	Taken	Taken
Anelex Building	Taken	Taken	Taken	Taken

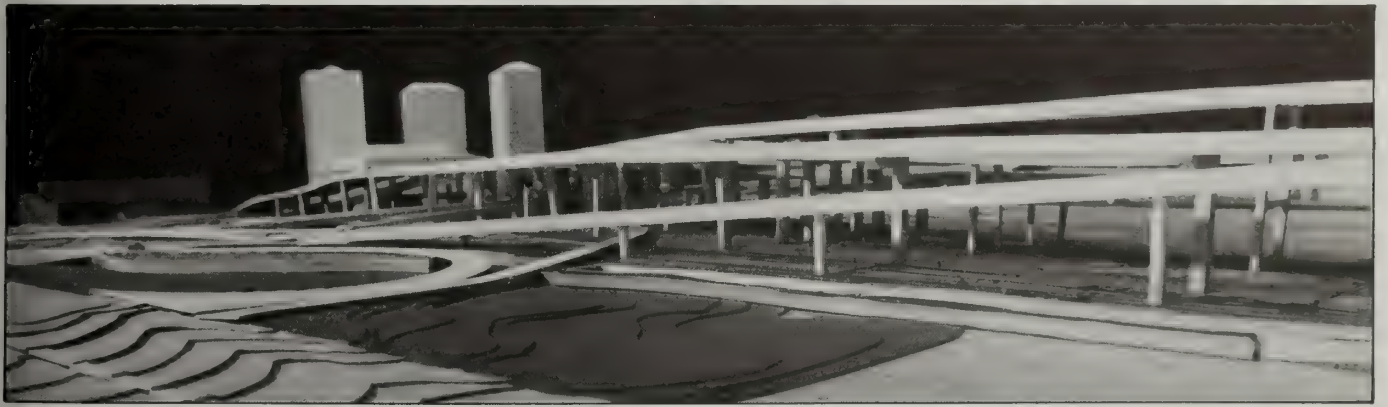
Source: Bechtel/Parsons Brinckerhoff



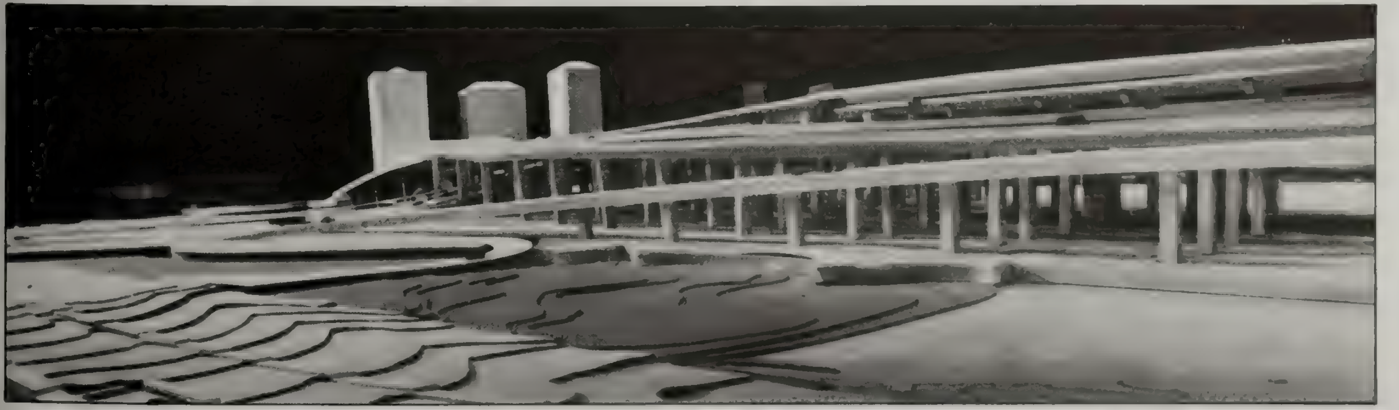
Existing View



5A Modified



T Modified

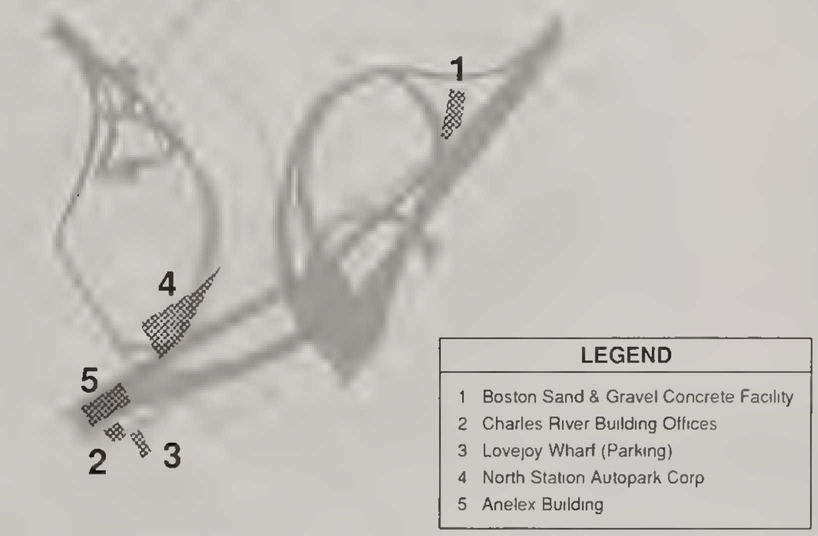


Z Modified

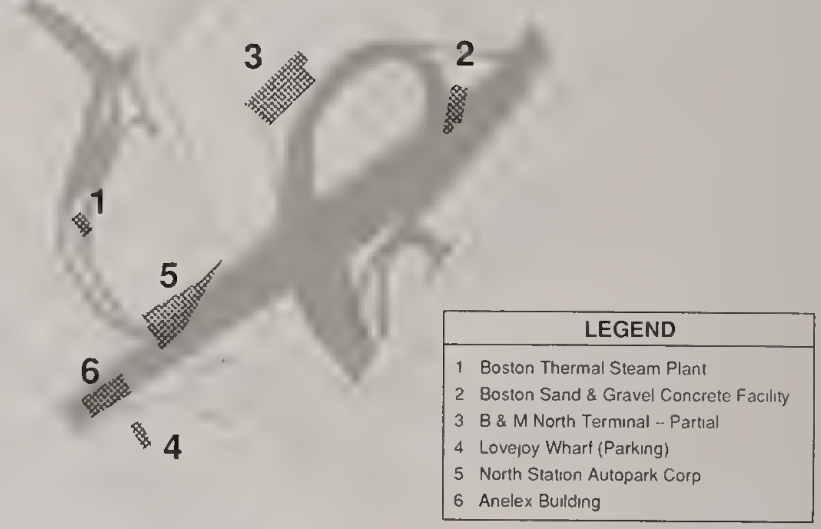
FIGURE
1.20

Views Of I-93/Route 1 Interchange By Option From Charlestown Residential Area, Looking Southwest

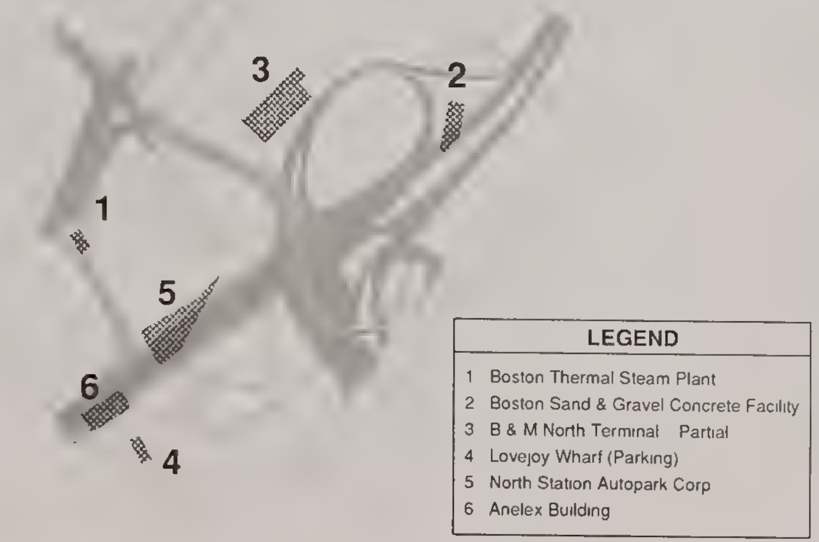
THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R


1
2
3
4
5
LEGEND
1 Boston Sand & Gravel Concrete Facility
2 Charles River Building Offices
3 Lovejoy Wharf (Parking)
4 North Station Autopark Corp
5 Anelex Building

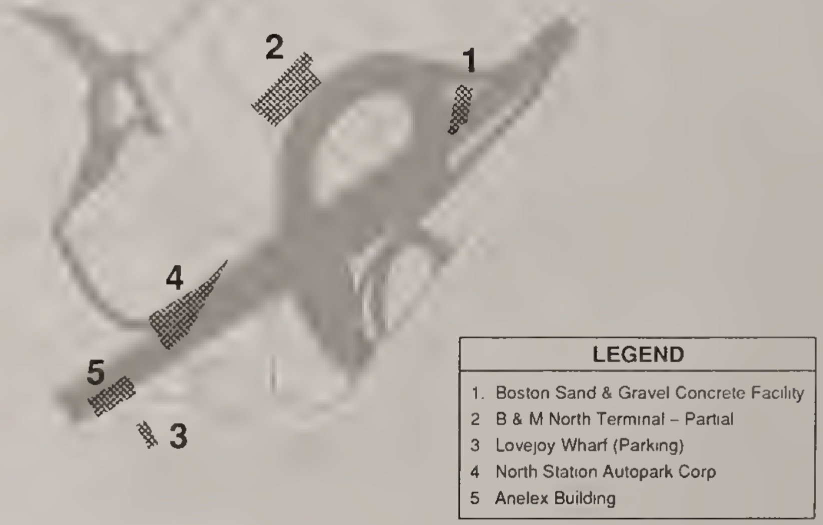
5A Modified


1
2
3
4
5
6
LEGEND
1 Boston Thermal Steam Plant
2 Boston Sand & Gravel Concrete Facility
3 B & M North Terminal -- Partial
4 Lovejoy Wharf (Parking)
5 North Station Autopark Corp
6 Anelex Building

S Modified


1
2
3
4
5
6
LEGEND
1 Boston Thermal Steam Plant
2 Boston Sand & Gravel Concrete Facility
3 B & M North Terminal Partial
4 Lovejoy Wharf (Parking)
5 North Station Autopark Corp
6 Anelex Building

T Modified


1
2
3
4
5
LEGEND
1. Boston Sand & Gravel Concrete Facility
2 B & M North Terminal – Partial
3 Lovejoy Wharf (Parking)
4 North Station Autopark Corp
5 Anelex Building

Z Modified

FIGURE 1.21 Relocation Impacts For 5A Modified, S Modified, T Modified, And Z Modified

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Option S Modified. The roadway alignment and provision of the ventilation building would require the taking of the Boston Thermal Corporation's steam plant on Minot Street. A full or major partial taking of the Boston Sand & Gravel facility would be required. (It is possible that on-site locations for relocated facilities may be feasible.) The B&M Railroad's North Terminal Building (a warehouse) will be affected. It is uncertain at this time whether a partial or total acquisition of the building would be required. Option S Modified will also require the taking of the loading dock of the Charles River Building, but no relocation is required.

Option T Modified. The roadway alignment and provision of the ventilation building would require a partial taking of the Boston Thermal Corporation's steam plant on Minot Street. A partial taking of the Boston Sand & Gravel facility would be required. (It is possible that on-site locations for relocated facilities may be feasible.) The B&M Railroad's North Terminal Building (a warehouse) will be taken due to the construction of a graving basin for construction of tunnel segments. Option T Modified will also require the taking of the loading dock of the Charles River Building, but no relocation is required.

Option Z Modified. A full or major partial taking of the Boston Sand & Gravel facility would be required. (It is possible, although not likely, that on-site locations for relocated facilities may be feasible.) The B&M Railroad's North Terminal Building (a warehouse) will be affected. It is uncertain at this time whether a partial or total acquisition of the building would be required.

Option Z Modified will also require the taking of the ice annex to the Boston Thermal Corporation's steam plant but no relocation is required, and the loading dock of the Charles River Building may be temporarily relocated during construction.

1.4.10 Historic Resources

The following section describes the impacts each option would have on historic resources in the Area North of Causeway Street. First, the historic resources which will be affected equally by all of the options in the Area North of Causeway Street include the following features.

Tower A. Tower A is located at the B&M tracks on the north side of the Charles River. It is historically significant as a surviving example of railroad architecture, and also for its technologically advanced signal system. The structure was built between 1928 and 1932, and continues to function as the signal tower. However, Tower A has been scheduled for demolition as a part of the CANA project, because it will no longer be able to perform signal functions as a result of that project. Moreover, all of the options would require the demolition of Tower A.

Bulfinch Triangle. The Bulfinch Triangle National Register District encompasses the eastern portion of the original Bulfinch Triangle street pattern. The architecture is diverse with the most distinctive structural type generally being the four- to six-story late 19th century brick warehouses. All of the options will have long-term positive impacts in this District by removing the Central Artery viaduct.

Several other resources will be affected differently by the different options.

100 Nashua Street. 100 Nashua Street is an eight-story public office building designed by Edward I.P. Graham. The 1932 building of cast stone with aluminum spandrels is an impressive example of Depression-era public architecture and is significant for its distinctive design characteristic of that period.

Options S Modified and T Modified would result in long-term adverse impacts to 100 Nashua Street by the placement of a ventilation building directly adjacent to the building.

Causeway/North Washington Streets District. The Causeway/North Washington Streets Historic District is considered eligible for listing on the National Register. The district comprises late 19th and early 20th century five- to seven-story brick buildings, having notable brick, stone, and metal detailing. The district is the eastern half of the original Bulfinch Triangle laid out by Charles Bulfinch in 1808; it is located between the elevated Central Artery and North Washington Street. The western half of the Triangle is west of the Central Artery viaduct and is listed on the National Register of Historic Places as the Bulfinch Triangle National Register District.

All of the options would have the long-term positive effect of removing the Central Artery viaduct which separates the two historic portions of the Bulfinch Triangle and would visually reconnect these two historic areas.

Option 5A Modified requires the taking of a portion of the Charles River Building and the loading dock at the west end of the Stop & Shop Bakery Building for the construction of the split bridge crossing of the Charles River. These impacts to the Stop & Shop Building and the Charles River Building would be considered a permanent alteration to the historic fabric and character of the Causeway/North Washington Streets District.

A 10-story ventilation building measuring approximately 60 feet by 80 feet would be built on the site of the western end of the Charles River Building. This new building would not be altogether out of character with the surrounding industrial area.

Options 5A Modified, S Modified, and T Modified would have other long-term impacts associated with ramps at Causeway Street such as increased traffic through the area via existing streets. This indirect impact could partially isolate the district, thereby reducing its economic viability and increasing the potential for loss of its other historic buildings.

Charles River Basin District. The Charles River Basin National Register District incorporates the Charles River Basin and the parkways and landscaped areas on both banks for approximately 6 miles upstream from the Charles River dam to the Elliot Bridge in Cambridge. Options 5A Modified, S Modified, and Z Modified would have no long-term adverse impacts to the district.

Comparison Of Options. Option Z Modified would have no adverse effects on the historic structures and districts. As with all options, it would have the positive effect of removing the Central Artery viaduct and visually reconnecting the Bulfinch Triangle District and the Causeway/North Washington Streets District.

The other options considered would adversely affect either the Charles River Basin District (T Modified), Causeway/North Washington Streets District (5A Modified, S Modified and

T Modified) or 100 Nashua Street (S Modified and T Modified). (It should be noted that 5A Modified was considered to have significant impacts on historic resources.)

1.5 CONSTRUCTION PERIOD IMPACTS

Because the Area North of Causeway Street, particularly on the south side of the Charles River, is constrained by so many high-volume vehicular and railroad facilities and intensively used buildings, all of the alignment options considered require many complicated and challenging construction procedures. This area is therefore the most technically difficult in the Artery/Tunnel Project. Each alignment requires some degree of underpinning of adjacent structures, modifications to existing bridge and viaduct structures, temporary roadway structures, staged traffic detours, construction in the vicinity of active commuter railroad areas, construction in the river, and work in confined areas with difficult access. For these reasons, throughout the process of developing, refining, and examining potential options, each option has been evaluated for the degree of impact on adjacent structures and facilities, construction methods and the corresponding degree of difficulty, the ability to maintain traffic movements throughout the construction period, and schedule impacts to the overall construction duration.

The discussion which follows highlights only those impacts or issues which differ among the options. Where impacts are likely to be similar, a statement to that effect is included.

1.5.1 Traffic Impacts

Each option includes different staging requirements and construction methods. These will in turn cause different impacts on traffic. The most important impacts are described below.

Option 5A Modified.

- o Loss of the connection between Storrow Drive and I-93 northbound for approximately 2 years. This is a very substantial adverse impact of this option.
- o Loss of the connection from I-93 northbound to Storrow Drive for 3 to 5 months.
- o Impacts to Storrow Drive westbound during construction of Leverett Circle.

Option S Modified.

- o Loss of connection from I-93 northbound to Storrow Drive for 3 to 5 months.
- o Some impacts to Storrow Drive eastbound during construction of Leverett Circle.

Option T Modified.

- o Very substantial detours around Leverett Circle for 1 to 2 years during period of tunnel construction.
- o Impacts to eastbound and westbound Storrow Drive traffic flow.

- o Loss of connection from I-93 northbound to Storrow Drive for 3 to 5 months.

Option Z Modified.

- o Some impacts to Storrow Drive eastbound during construction of Leverett Circle.

1.5.1(a) Comparison Of Impacts

Option Z Modified would have the least impact on traffic operations during the construction period and would not require the loss of any major connections for any significant time period. Option S Modified would be similar to Z Modified, with the addition of the loss of one major connection for 3 to 5 months. The impacts of option T Modified would be significant. Due to the loss of a major connection for 2 years, the impacts of option 5A Modified are unacceptable.

1.5.2 Air Quality Impacts

There are not likely to be substantial differences in construction period air quality impacts among the options.

1.5.3 Noise And Vibration

Construction period impacts would be somewhat less favorable in those options involving tunneling construction, particularly option T Modified. These impacts would continue, with varying degrees of intensity depending on the particular phase of the work, over a period of 7 to 8 years. Both noise and vibration impacts would be felt during the period of construction at adjacent land uses. Construction noise and vibration would be determined by the construction techniques employed, equipment used, and phases of the operation.

T Modified would involve extensive tunneling on both sides of the river, as well as at the river crossing. Tunneling across the river would involve blasting of bedrock and foundation structures. Blasting noise levels would depend on the charge weight and depth of rock removed per blast. These repeated impacts would generate annoyance to residences within 1,000 feet. Tunnel construction would also generate noise impact associated with installation of sheet pile for cofferdams and excavation support walls, excavation equipment, trucks, cranes, and other miscellaneous equipment.

Construction vibration impacts would affect nearby structures depending on distance from the vibrating equipment or blasting operation. Blasting would generate much higher vibration levels than other methods of construction proposed in these options. The impacts on structures adjacent to the blasting operation required in T Modified are of particular concern and would require further analysis.

Other construction operations that would generate noise and vibration impacts are pile driving for new bridge and viaduct supports; jack hammering and pavement breaking required during the removal of existing roadway, bridge and viaduct structure; and general construction work including excavation, erection of structures, and concrete placing.

Mitigation measures are available to reduce noise and vibration impacts associated with the operation of construction equipment, and these measures would be implemented with any option. Noise and vibration levels will be consistent with Boston City Noise Code requirements.

1.5.4 Wetlands, Aquatic Ecology, And Water Quality

All of the options will entail construction of bridges across the Charles River, with the attendant construction of piers within the river. The impacts of the bridge construction will be similar for the four options.

Options S Modified, T Modified, and Z Modified will have construction impacts on the Millers River, which are different than those of the CANA ramps (option 5A Modified does not change the CANA ramps). The potential exists for releasing contaminated material now contained in Millers River sediments. The application of sediment control techniques will minimize the potential for contaminant release. The highly polluted nature of the existing Millers River suggest that aquatic impacts of construction in this area will be minor.

Options 5A Modified and T Modified also entail tunnel construction, with 5A Modified including a narrow tunnel which follows the south bank of the Charles River, and T Modified including a crossing of the river from shore to shore.

Option T Modified would have the greatest construction period impact on aquatic ecology and water quality. The removal of about 250,000 cubic yards of unconsolidated material and an additional 90,000 cubic yards of rock will temporarily disturb about 4 acres of river bottom. This is about one-quarter of the river bottom between the tunnel crossing and the new Charles River dam. Such extensive disturbance would depress benthic production in this area and affect the resident fish population in this section of the river during construction. Long-term benthic effects would be minimal because the river bottom will be returned to a shape that is similar to what it is at present, and consist of a similar substrate. The level of contamination in the material used for backfilling the trench would be less than what it is at present and thus would have a positive effect on the organisms recolonizing the area to be disturbed.

Water quality impacts of option T Modified would involve increased suspended solids associated with dredging and dewatering cofferdams and the casting basin. Observations of suspended solids in the Charles River ranged from 6.8 to 7.2 parts per million (ppm) and 6 to 15 ppm in the Millers River. Silt screens will contain suspended particles associated with dredging to some extent, but the water in the lower Charles River would be noticeably muddier than it is at present. Turbid conditions which are related to the concentration of suspended solids will depress phytoplankton production, but warm water fishes will tolerate conditions exceeding 100 ppm of suspended solids without displaying direct adverse effects. The application of sediment control techniques should maintain turbidity levels well below this level but somewhat elevated from the level which exists at present.

1.5.5 Floodplains

None of the options would entail construction period impacts to floodplains.

1.5.6 Waterways/Navigation

All of the options include the construction of bridges across the Charles River. The bridge piers and pier caps associated with all the design options would be constructed by either the slurry caisson or the tremie concrete/cofferdam method with final determination made by the contractor. The tremie concrete method would consume the most space, with each operation involving a construction barge operating near a cofferdam measuring approximately 40 by 50 feet. Although only one tremie operation would be underway at any given time, in some cases up to three neighboring columns could be constructed within the same cofferdam. Cofferdams accommodating more than one tremie operation could measure up to 40 by 150 feet. Individual cofferdam/tremie operations would take 4 to 6 months to complete, depending on the size and complexity of the jobs. The 5A Modified slab piers would be constructed using similar methods. However, the size of the individual cofferdam operations would be much larger and those operations would take longer to complete.

The construction impacts of S Modified and Z Modified would be identical, with eight cofferdam operations. T Modified's bridges would require six cofferdams (in addition to major cofferdams required for its Charles River tunnels), while 5A Modified would have four cofferdams. The 5A Modified cofferdam operations would be much larger than those associated with the other options, and they would extend for longer periods. The navigation channel would remain open during construction under any option.

Immersed Tube Tunnel Construction Impacts. The navigation impacts of the construction of the tunnels in option T Modified are more significant than those of the other options.

Navigation impacts would be caused by three types of construction activities: stationary cofferdam operations, waterborne construction rigs, and construction barge movement. There would be three cofferdams involved located on both banks of the river in the transition areas between the cut-and-cover segments and the immersed tube sections, and at the casting basin. The cofferdams would be comprised of cells of up to 60 feet in diameter and would consume considerable amounts of space.

Various construction rigs would be involved in dredging, blasting, and tunnel foundation operation. In most cases, these activities would involve a moored construction barge which would be accompanied by haul barges during work hours. These rigs would occupy a considerable portion of the river's width and would obstruct the shipping channel during certain periods. In order to maintain maritime traffic, temporary channels would have to be established, which would involve additional dredging.

The placing of the immersed tube sections would be the most sensitive phase of the tunnel construction. Upon completion of the tunnel foundation, the casting basin cofferdam would be breached, and the six 250- by 45-foot tube sections would be floated into the river. The tubes would be lowered one at a time, taking approximately a week each. The tube sections would be sensitive to water turbulence while being lowered and during the initial phases of the underwater joining process, during which time maritime activity in the Lower Charles River might have to be curtailed. The entire tube placement phase would take approximately 6 weeks.

1.5.7 Land Use

There are some coordination issues which would affect construction of North Station/Boston Garden which result from options 5A Modified, S Modified and T Modified which include tunnels in this area (see Section 1.4.7 above). Construction of the T Modified tunnels would delay development of the North Point area in Cambridge more than other options. Otherwise, construction period impacts to land use would be similar for the four options.

1.5.8 Open Space And Parklands

At Paul Revere Landing Park, on the south bank, options 5A Modified, S Modified, and T Modified would require tunnel construction across the pedestrian path to the Charles River Dam, disrupting access for several months. Option Z Modified has no tunnels in this area, and pedestrian access would be maintained continuously, except for brief interruptions to protect the safety of users.

The north bank portion of Paul Revere Landing Park is currently closed during construction of the CANA project (except for pedestrian access to the dam). This part of the park could be restored to use approximately 2 years prior to completion of options S Modified, T Modified, and Z Modified. Under 5A Modified, which involves a bridge over the corner of the park, restoration could not occur until the end of Artery/Tunnel Project construction in this area.

The walkway over the Charles River dam would be closed during construction of the overhead bridge in 5A Modified. The walkway would remain open in other options, but there would be disruption of views, due to construction of upstream bridges in S Modified, T Modified, and Z Modified, plus the construction of tunnels across the river in T Modified.

Leverett Circle and the Esplanade would be affected by construction of 5A Modified, which would temporarily use a strip of land along the Esplanade tennis courts. Options S Modified and Z Modified would not affect land between Storrow Drive and the river, but would require replacement of the pedestrian bridges at Leverett Circle and Blossom Street. Access would be continuously maintained on at least one of the bridges at all times. T Modified would have a similar effect on pedestrian bridges, but would also require a strip of land on the Esplanade side of Storrow Drive during connection to the westbound tunnel across the river.

The Nashua Street parkland parcel would be severely affected both permanently and during construction by the tunnel and surface street connections of option 5A Modified. The entire parcel would be disrupted for approximately 2 years during construction of the cross-river tunnels in T Modified. There would be no construction impact on this parcel in options S Modified and Z Modified.

The GSA parkland parcel would be affected only by Option T Modified, which would involve major construction in the river adjacent to the parcel and potential use of a part of the parcel for a graving basin for the construction of sunken tube segments for the tunnels.

All options would involve some construction period disruption to the MBTA trestle walkways along the river near North Station.

In all options, open space improvements to the MDPW owned CANA right of way would commence near the completion of the I-93/Route 1 interchange.

1.5.9 Visual Impacts

Construction period visual impacts would be similar among the four options, and would be substantial in all cases.

1.5.10 Relocation

The relocation impacts described above in Section 1.4.9 include those which would occur as a result of construction activities alone, as well as those which occur as a result of permanent project elements.

1.5.11 Historic Resources

Construction period impacts to historic resources would be similar among the four options.

1.5.12 Constructibility

Due to the differences in alignment and project elements among the four options, there are some important distinctions in construction process and difficulty. These differences affect the duration of construction and the impacts of construction which are described above in Sections 1.5.1 to 1.5.11. In order to clarify these issues, the following brief discussion of constructibility was prepared.

Option 5A Modified.

- The physical conflict between the ramp from Storrow Drive to I-93 northbound and the existing bridge and viaduct will result in the loss, without replacement, of the movement from Leverett Circle/Storrow Drive to I-93/Route 1 northbound for a period of 2 years.

- Construction of the I-93 northbound to Storrow Drive and Storrow Drive to I-93 southbound tunnels along the Charles River south bank would involve a watertight excavation support system, probably comprised of interlocking sheet piling. Installation of this system below the railroad tracks leading into North Station, while underpinning and maintaining service on the tracks, would be very difficult because of restricted overhead clearances. An alternative to underpinning the tracks would be the construction of a temporary bridge over the river to accommodate seven railroad tracks. Underpinning of a portion of the Spaulding Rehabilitation Hospital would be required where the tunnels pass below.

- The I-93 southbound to Storrow Drive and Storrow Drive to I-93 northbound elevated connectors would be in conflict with the existing double-decked ramp viaduct behind North Station and could not be constructed until the viaduct was removed. In order to maintain service from I-93 southbound to Storrow Drive/Leverett Circle, a temporary viaduct would be required.

- The tunnel ramp from I-93 northbound to Storrow Drive would require the removal of a portion of the Charles River Building. This site could then be used for location of a ventilation building.

- Because of the split bridge alignment of the I-93 mainline viaducts north of the Charles River, bent modifications would be required on both sides of the existing two-level structure. The split bridge alignment would require construction of a permanent structure over the MDC Charles River dam.

Option S Modified.

- Because the S Modified alignment would use a parallel bridge option with a separate two-level crossing for the Storrow Drive/Leverett Circle connections, the alignment could be constructed without the long-term loss of the Storrow Drive to I-93 northbound movement. The alignment would provide the opportunity to schedule the completion of the viaducts in such a way that it would enable early use and benefit of portions of the new roadway system prior to the completion of the new mainline roadway, and also allow the early removal of portions of the existing ramp viaduct to/from Storrow Drive, thereby decreasing the amount of structure that must be underpinned to construct the mainlines and improving construction accessibility.

- The S Modified tunnel alignment will require the underpinning of the commuter rail tracks into North Station and the existing viaduct structure.

- The I-93 southbound to Storrow Drive and Storrow Drive to I-93 northbound elevated connectors would be in conflict with the existing double-decked ramp viaduct behind North Station and could not be constructed until the viaduct was removed. In order to maintain service from I-93 southbound to Storrow Drive/Leverett Circle, a temporary two-level viaduct would be required.

- Because S Modified would have a parallel bridge alignment, the bent modification work to merge the new northbound and southbound viaducts can be performed on one side of the structure.

- Construction of the Storrow Drive to I-93 southbound tunnel and tunnel approach would require a two-tier tunnel with the project tunnel over the Green Line. Construction of this facility would have to be closely coordinated with the MBTA.

Option T Modified.

- The major construction impacts of the T Modified alignment would be the unique difficulties associated with the construction of the subaqueous river crossing. (A discussion of these difficulties is included in a separate subsection at the end of this section.)

- The T Modified alignment will put the tunnel ramps connecting Storrow Drive to I-93 southbound and I-93 northbound to Storrow Drive in a corridor in the vicinity of the existing viaduct. Underpinning of the commuter railroad tracks into North Station and the existing structure would be required.

- T Modified would not conflict with the existing ramp viaduct behind North Station and would not require a temporary two-level viaduct to maintain traffic during construction.

- Because T Modified would have a parallel bridge alignment, the bent modification work to merge the new northbound and southbound viaducts can be performed on one side of the structure.

- T Modified would involve additional roadway structure to accommodate a right-hand off movement for northbound traffic destined for Route 1. This feature also would require separate roadway structure for traffic entering the system from Causeway Street. The separate roadway structure for the northbound on-ramps would have to be constructed in a latter phase, after the existing bridge is removed. By allowing traffic entering at Causeway to go only to Route 1 and requiring traffic to northbound I-93 to take the Charlestown bridge and enter I-93 on the ramp until the existing bridge is removed and the new structure completed, all traffic movements could be maintained throughout construction.

- The new eastbound underpass would pass below the existing westbound underpass at Leverett Circle. Underpinning of this structure would be required to avoid a closure of this facility for approximately a 2-year period. Although a difficult procedure, underpinning of this structure, pending further study, appears feasible.

- Closure of the existing westbound underpass at Leverett Circle would be required during the construction of the Storrow Drive to I-93 southbound tunnel which would pass through the existing tunnel approach. During this operation, a portion of the deeper tunnel connector from Merrimac Street would be constructed first. Approximately a 12-month closure of the tunnel could be anticipated. During this period, traffic exiting the lower level of the viaduct would be detoured around the Circle to a temporarily widened Storrow Drive. Additional traffic detours for surface traffic at the Circle along Nashua Street, O'Brien Highway, Lomasney Street, and Martha Way would be required to complete the tunnel structures in this alignment.

- Construction of the tunnel connector and approach from Merrimac Street to the Route 1 northbound tunnel would be in conflict with the existing viaduct structure and could not be constructed until after the rest of the facility was placed in service and the existing viaduct removed. During this interval, traffic destined for Route 1 could enter from Causeway Street. Approximately 12 to 18 months after completion of the rest of T Modified, the Merrimac Street connector would be completed.

- Construction of the Storrow Drive to I-93 southbound tunnel and tunnel approach would be in the same horizontal alignment as the depressed Green Line tunnel and approach to the elevated structure at Science Park station. A two-tier tunnel with project traffic over the Green Line tunnel would be required to accommodate the space restrictions. Construction of this facility would have to be closely coordinated with the MBTA.

- The ventilation building for T Modified on the north side of the Charles River is located on a site which has very constrained access, would be above tunnels to and from Route 1, between the CANA loop ramps (already completed and in service during construction of the ventilation building), northeast of the commuter rail corridor, and bordered by the new southbound mainline to the northeast. Access problems are likely to cause some construction difficulties, particularly during installation of heavy mechanical and electrical equipment.

Option Z Modified.

- The Z Modified alignment would provide the opportunity to schedule the early completion of all the moves to and from Storrow Drive/Leverett Circle on an independent and earlier schedule. This would enable the earlier use of this portion of the roadway system. The removal of additional portions of the existing ramp viaduct to/from Storrow Drive, would decrease the amount of structure that would have to be underpinned to construct the I-93 mainlines.

- The new viaduct providing the movements to and from Storrow Drive/Leverett Circle would be in conflict with the existing ramp viaduct behind North Station and could not be constructed until the viaduct was removed. Movements would be maintained during construction by a temporary two-level viaduct constructed over the North Station tracks and Massachusetts General Hospital property.

- Z Modified would have a parallel bridge alignment allowing bent modification work to be performed on one side of the existing I-93 double-deck structure.

- Z Modified would entail the greatest amount of elevated structure north of the Charles River, and a corresponding increase in the area required for construction. The added amount of structure would increase the number of large spans (200+ feet) to be erected over the MBTA commuter railroad tracks to/from North Station, the MWRA chlorination pumping station facility, and active in-service roadways in the area. This, combined with a decrease in construction access and maneuvering area, would add to the difficulty and complexity of the erection procedure.

1.5.13 Construction Of Tunnels Under The Charles River

Although there are many constructibility issues with all of the Area North of Causeway Street alignment options, the issue of constructing tunnels under the Charles River from Leverett Circle to Charlestown, with all the attendant impacts to the surrounding area, is identified as the most significant. These tunnels would be particularly difficult to build because of the complicated mix of subsurface conditions in the area, and the constrained area within which navigation must be maintained while construction is underway.

The tunnel in Option T Modified would involve the construction of two two-lane boxes with cross sections of approximately 24 feet high by 45 feet wide. The profile of the tunnel crossing is governed by the following geometric constraints:

- The Route 1 northbound tunnel must pass below the existing Leverett Circle underpass.

- The Route 1 southbound tunnel must remain below Leverett Circle surface roads and emerge in a boat section on Storrow Drive, just beyond the existing Circle.

- On the Charlestown side, the Route 1 tunnels must remain below the surface as they pass below the MBTA commuter railroad tracks leading to North Station.

- The Route 1 tunnels must pass over the MBTA Orange Line tunnel.

- The Route 1 tunnels must join the grade of the CANA tunnels currently under construction.

- The roof of the Route 1 tunnels must pass below the surface of the river bottom to avoid affecting river flow, sediment buildup, or navigation.

- Project design criteria require that grades do not exceed 6 percent.

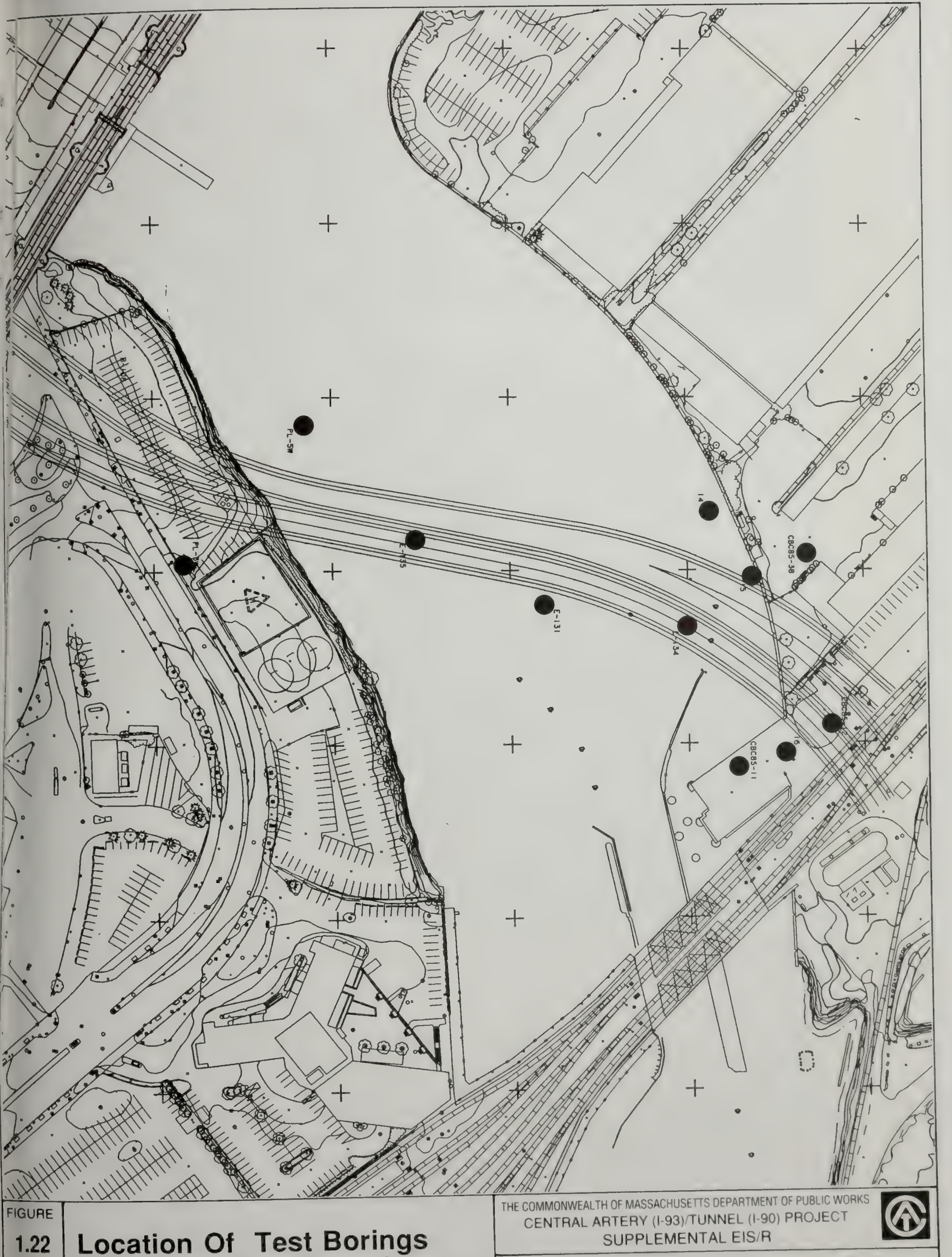
Given these parameters, a tunnel profile for the crossing was developed. The vertical curve used in the profile requires a 4 percent slope on the Boston side and a 3.8 percent slope on the Charlestown side of the crossing. A more gradual profile would fail to pass below the Leverett Circle underpass. A steeper profile is possible with up to 6 percent; however, this would tend to increase earth and rock excavation quantities required during construction.

Test borings along the alignment and in the vicinity have been conducted as a part of several previous independent geological investigations in support of other projects in the area. (The locations of these borings are shown on Figure 1.22.) Boring logs from these programs were reviewed and plotted to indicate the subsurface geological profile of the tunnel area. The profile indicates decomposed argillite approximately 30 to 40 feet below existing ground on the Charlestown riverbank, with the rock line sloping off along the alignment until reaching depths of 60 to 70 feet below existing ground on the Leverett Circle riverbank. On the Charlestown side, the decomposed argillite is covered by a layer of black organic silt varying from 5 to 10 feet deep across most of the river. The Leverett Circle side is comprised of layers of oily sand and organics, mixed fill, stiff and medium clay, and fine sand before hard glacial till and argillite are reached. The subsurface profile and boring logs indicate mixed face conditions (i.e., passing from rock to earth) with argillite material of variable soundness, from decomposed to very hard.

Recognizing that river navigation for commercial and recreational uses must be maintained throughout the construction period, the following methods of construction for the tunnel crossing were considered:

- tunneling
- staged cofferdam construction
- immersed tube
- combination tunneling/cofferdam

The tunneling and combined tunneling/cofferdam methods, which include use of tunnel boring machines, conventional mining techniques, and NATM (New Austrian Tunneling Method), were determined to be unacceptably dangerous due to the highly variable condition of the underlying rock, and were therefore deemed infeasible. The inadequate crown cover of rock over the tunnel section, ranging from 0 to 12 feet (using the steepest profile permissible without exceeding 6 percent grades), as well as concerns regarding the weathered and fractured condition of the rock, have led to the recommendation that these methods be deleted from further consideration.



FIGURE

1.22

Location Of Test Borings In Charles River Tunnel

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SUPPLEMENTAL EIS/R

1.5.2(a) Staged Cofferdam Construction

A cellular sheetpile cofferdam system, comprised of steel interlocking sheetpiles, is required to provide a watertight excavation area under this method. Because river navigation for commercial and recreation traffic would be maintained at all times, the cofferdam system must be constructed in two stages. The phasing of work at the tunnel crossing into two construction stages would tend to extend the duration of this work. All work in the first phase (including cofferdam installation, dredging, blasting, rock removal, tunnel construction, backfill, and cofferdam removal) would have to be completed before the process could be repeated in Phase II. Consequently, the completion of work in the subarea could be expected to be extended by 1 to 2 years utilizing the staged cofferdam method (see Figures 1.23 and 1.24).

The design and construction of these cofferdams present some unique problems. One concern would be the ability to achieve sufficient penetration of steel sheets into rock for an effective seat. Another concern would be the proximity of the bascule commuter railroad bridge and the foundation of the old railroad bridge (removed) to the cofferdam. Blasting of the old existing concrete structures would probably be required. A means of protection for the active railroad bridge from blasting vibrations during this work would be required as well. Constructing an underpinning system to support the railroad tracks just north of the bascule bridge, as well as installing an excavation support wall capable of resisting the approximately 60-foot-deep excavation below the tracks, would add further complications to the operations in this area. Construction of the excavation support and underpinning systems would require periodic closures of the railroad tracks into North Station over a 3- to 6-month period.

The primary concern with the staged cofferdam method would be during the blasting and rock removal phase. The rock boring data indicate a highly variable condition of the rock in this area. Fractures, fissures, water-bearing seams, joints, intrusions, and layers of decomposition can be interpreted from the available data and can be anticipated from the general characteristics of the weathered argillite encountered throughout the Boston area. Because of these characteristics, the stability of the cofferdam structure would be questionable as is, the ability of the rock foundation to resist the lateral loads of up to a 25-foot depth of water. To the extent that failure planes, seams, joints, fissures, etc., can be identified, remedial measures (such as grouting, rock bolting, shoring, and bracing) could be implemented. However, the high degree of risk associated with this method cannot be ignored. Failure of the cofferdam system could result in flooding of the work area and, in the worst case, catastrophic failure endangering the lives of the workers at the site.

Because of these considerations, the staged cofferdam construction method is not recommended in this area.

1.5.2(b) Immersed Tube Tunnel

Immersed tube float-in sections could be constructed of either steel or concrete. Prefabricated floating steel tube sections are precluded by the restriction of the MDC dam and locks. On-site steel fabrication, although not impossible, would entail the construction of a major fabrication facility in the vicinity of the Charles River basin. The area requirements for this facility, as well as environmental, logistics, cost, and schedule considerations, make this an impractical approach.

Although not without problems, a concrete casting basin, similar to the one proposed for the Fort Point Channel crossing where restrictions preclude remote fabrication, is more feasible. The casting basin could not be constructed within the proposed cut-and-cover right-of-way for the tunnel and would have to be constructed solely for the purpose of fabricating the concrete tubes. The proposed location for this facility would be the area indicated in Figure 1.25, which encompasses the land of the Northern Terminal warehouse as well as a portion of the North Point development area. An area approximately 250 feet by 600 feet and 30 feet deep, requiring the removal and eventual replacement of approximately 170,000 cy of material, would be required for the basin. A cofferdam comprised of circular cells approximately 30 feet in diameter would be required to form the water access point. Following completion of the construction of the tube sections and the installation of temporary bulkheads, the cofferdam at the water access side of the casting basis would be breached and the tube sections floated into position for sinking into the prepared tunnel trench.

Preparation of the tunnel trench to the required depth would entail extensive dredging and blasting within the river area. The first phase of this work would be to dredge approximately 250,000 cy of silts, sands, and clays. The slopes of the trench for this material would be very "flat" (probably 5:1); although the characteristics of the material, currents in the river, and the effects of blasting could necessitate even flatter slopes and extend further the area to be dredged. Additional dredging to accommodate the draft of float-in tube sections also is to be anticipated. Contaminated material in the first few feet of river bottom sediment would involve special handling and disposal procedures. In addition, the temporary deepening of the river by up to an additional 40 to 50 feet at some locations will require extensive protection of the adjacent riverbanks to prevent slope failure into the river.

Following dredging to the required elevation, an extensive underwater blasting operation would be required. Blasting a trench approximately 100 feet wide through 25 to 30 feet of rock is required. Approximately 90,000 cy of rock excavation would be necessary.

While the fabrication and trench preparation work is underway, cut-and-cover construction of the tunnels approaching the river, behind the cofferdams, would be taking place. Following completion of the landslide tunnel work, bulkheads defining the river edge and capable of withstanding the water pressure loads after the cofferdams are breached would be constructed. Breaching the cofferdams would enable the joining of the flotation segments to the cut-and-cover segments.

Following completion of the tunnels, backfill of the river dredged area and casting basin would be required. The opportunity to reuse material excavated during the preparation of the tunnel trench and construction of the casting basin would likely be limited by the requirement of finding vacant land suitable for stockpiling material. Possibly some percentage could be stored; however, the majority of the approximately 450,000 cy would be imported from borrow areas.

Duration of construction of option T Modified, using a concrete immersed tube tunnel method, while somewhat shorter than the staged cofferdam method, could be expected to take an additional 6 to 12 months over other Area North of Causeway Street options.

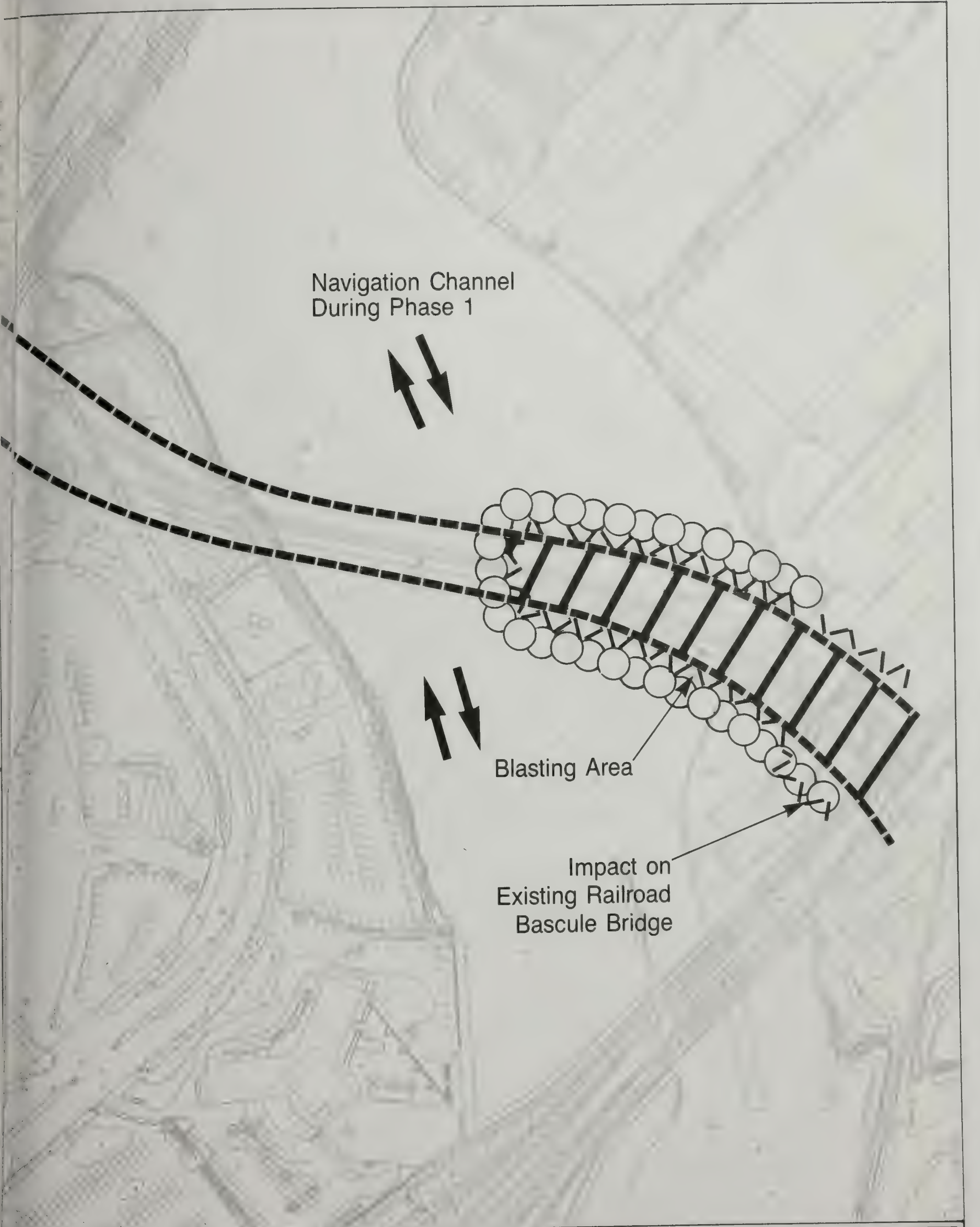

FIGURE
1.23

Cofferdam Staged Construction Phase 1

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SUPPLEMENTAL EIS/R

0 25 50 100 200 Feet

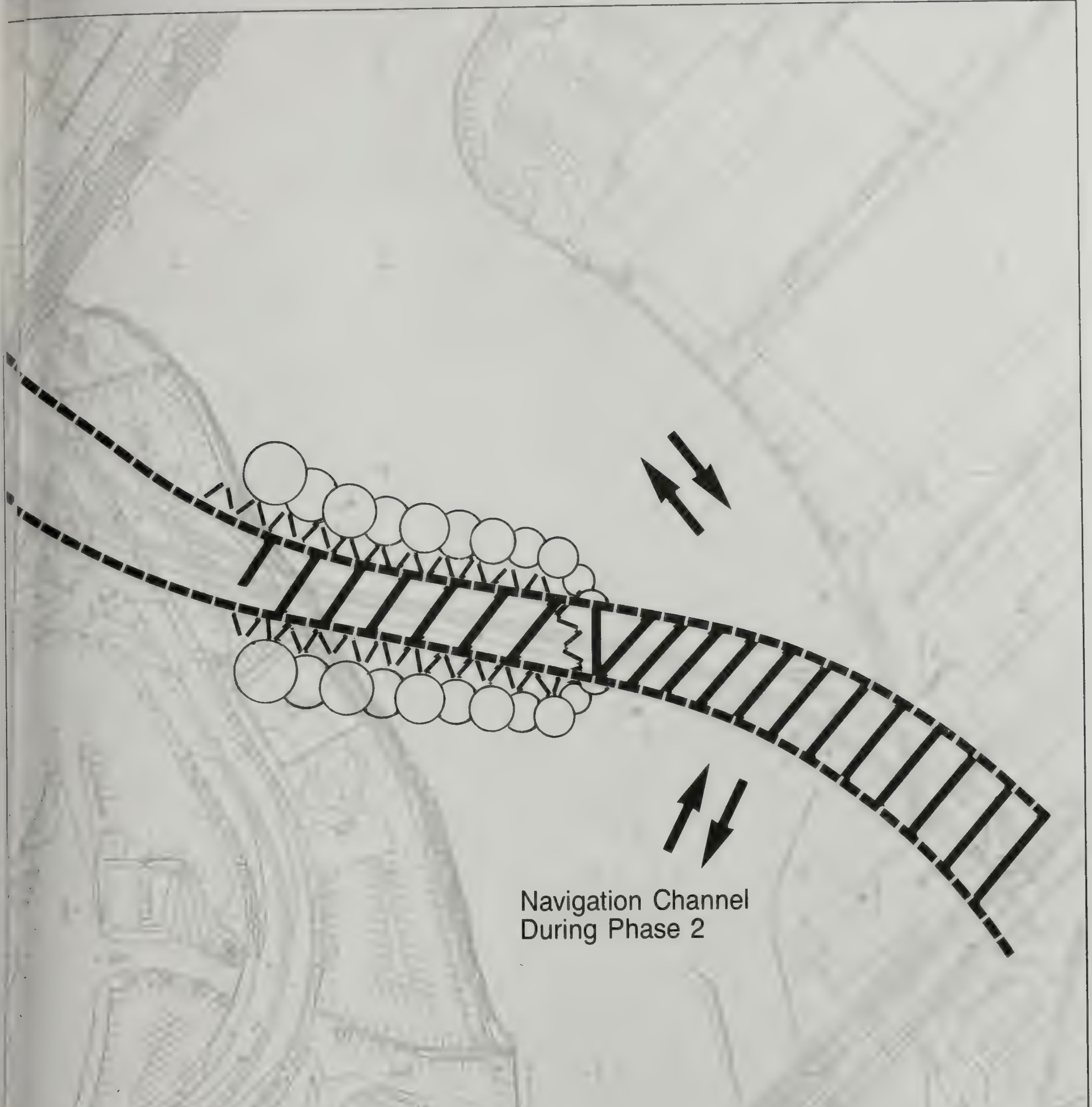

FIGURE
1.24

Cofferdam Stage Construction Phase 2

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 25 50 100 200 Feet

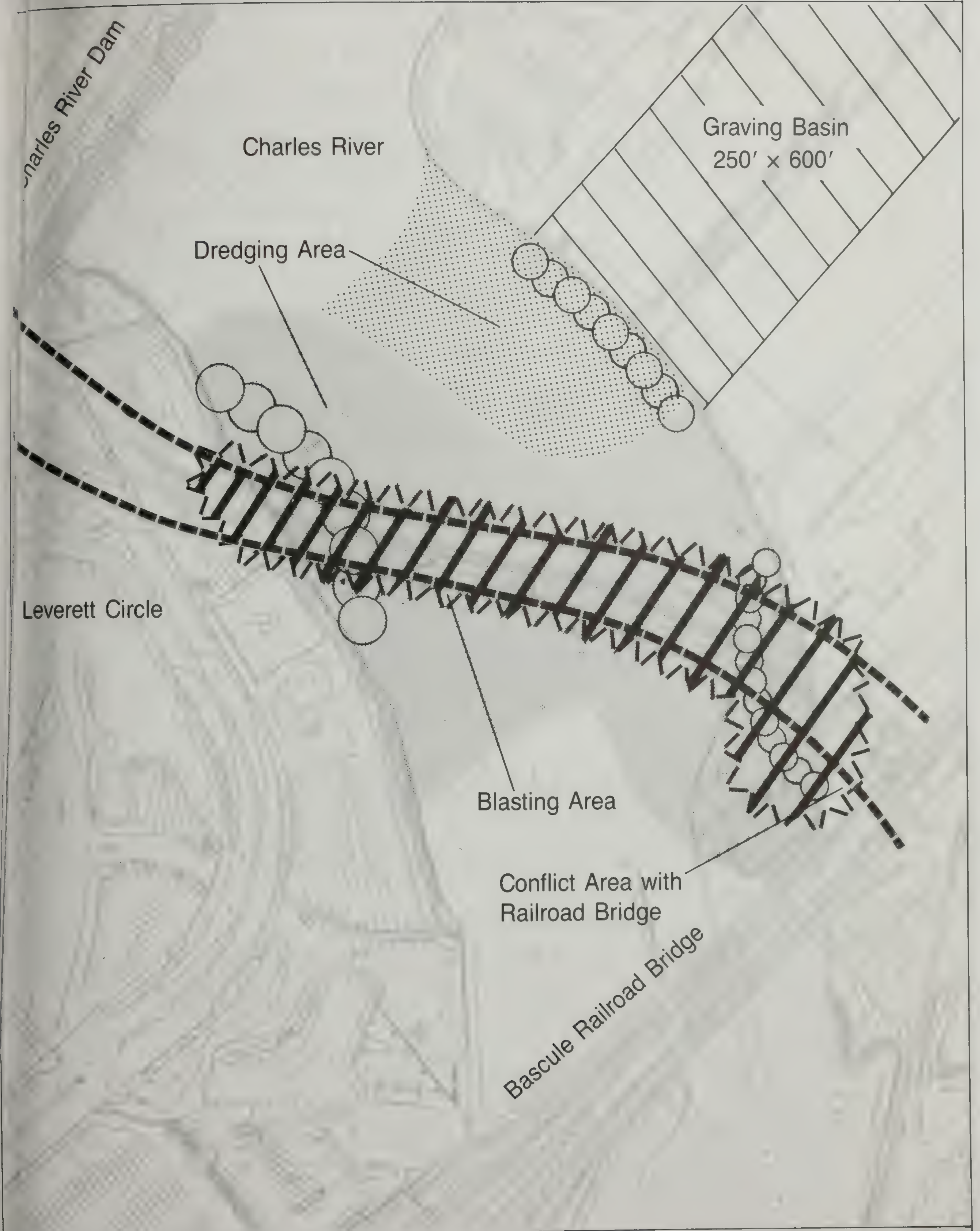

FIGURE
1.25 **Immersed Tube Tunnel**

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 25 50 100 200 Feet

1.6 RELATED DESIGN ISSUES

Several other specific design issues which affect a number of the options were addressed during the design evaluations. These are briefly described below.

1.6.1 Ventilation Building Locations

A special analysis was conducted to select the most appropriate and feasible locations for the required ventilation buildings for each option. The identification of sites was accomplished using the following process for each option:

- Tunnel sectors requiring independent ventilation systems were identified.
- Parcels of land within approximately 300 feet of each proposed tunnel were identified as potential sites for ventilation buildings. (Beyond 300 feet from the tunnel, the size and cost of connecting ductwork, and the extent of necessary utility relocations become prohibitive.)
- Each proposed building site was evaluated according to the following criteria:
    - Adequate site size (20,000 square feet)
    - Adequate site configuration (minimum site dimension of 80 feet)
    - No displacement of residential land uses
    - No displacement of major existing facilities
    - Avoidance of significant impacts on designated historic resources and parklands
    - Avoidance of need for fill in water or flowed tidelands
    - Compatibility with construction staging
    - Avoidance of conflicts with major existing subsurface obstructions

Air quality was not considered directly. Results of previous analytical and physical modeling studies are detailed in Part I, Chapter 4, of this SEIS/R. They indicated that ventilation buildings could be constructed within even the most constricted portions, of the Central Area, without resulting in violations of the National or State Ambient Air Quality Standards (AAQS) or DEP Policy Guidelines. The following sections summarize the results of this site selection process.

Option 5A Modified. In 5A Modified, the ventilation building site proposed in the FEIS/R was retained. Option 5A Modified includes one ventilation building located at the Charles River Building site (Site A) immediately to the east of the proposed alignment and just south of the Charles River (see Figure 1.26). The location of one of the 5A Modified tunnel ramps would require the taking of at least one 100-foot-long bay of the Charles River Building; this building is eligible for designation as an historic landmark on the National Register of Historic Landmarks. Engineering analyses undertaken since the FEIS/R indicate that the routing of necessary ducting between a ventilation building at this location and the tunnel carrying the southbound lanes of the Central Artery would not be feasible. In addition, the building would potentially have substantial visual impacts, because it would be located at the site of a pedestrian access point between Charlestown and the North Station area which is expected to experience heavy use due to new developments.

Option S Modified. One ventilation building would be required to ventilate the tunnel portion of this option, with tunnel portals at relocated Nashua Street and between Lomasney Street and Martha Way. Five potential ventilation building sites were identified for S Modified (see Figure 1.26):

- Charles River Building site
- MGH parking lot site
- Boston Thermal Corporation site
- Registry site
- Lomasney Street site

The Charles River Building site was eliminated because no tunnel ramps affect the building in this option and both technical issues and historic impacts make this site inappropriate.

The size and configuration of the other four sites are sufficient to accommodate a ventilation building. None of these sites would have impacts on parklands or cultural resources, and no fill would be required in water bodies. Specific impacts at each site are listed below.

Construction of a ventilation building at the MGH parking lot site would require taking of a portion of MGH property, and would potentially have visual, noise, and vibration impacts on the hospital itself.

The taking of the Boston Thermal steam plant is required for construction of the highway ramps for this option. Locating a ventilation building at the Registry site would require taking the Registry building which is eligible for inclusion as an historic building on the National Register.

Locating a ventilation building at the Lomasney Street site would involve constructing the building over the highway sections in this area -- this option is not feasible because it would preclude essential construction staging requirements related to traffic maintenance.

Based on this analysis, it is recommended that the ventilation building for S Modified be located at the Boston Thermal site. Its size and configuration are sufficient to accommodate a facility; construction at this site would be compatible with construction staging plans; there would be no impacts on parklands or cultural resources; and no fill would be required in water bodies. Relocation of this utility would be difficult, however, due to licensing and permitting requirements.

Option T Modified. T Modified would require the ventilation of a portion of tunnels similar (although somewhat longer) to those in S Modified, as well as portions of additional tunnels under the Charles River and in Charlestown (see Figure 1.26). Two ventilation buildings would be required for this option. One would be at the same location as S Modified (Boston Thermal site); four potential sites were identified for the second location:

- South bank Esplanade sites (planned parkland)
- North bank Esplanade site (proposed parkland)
- MBTA Tower A site
- Boston Sand & Gravel site

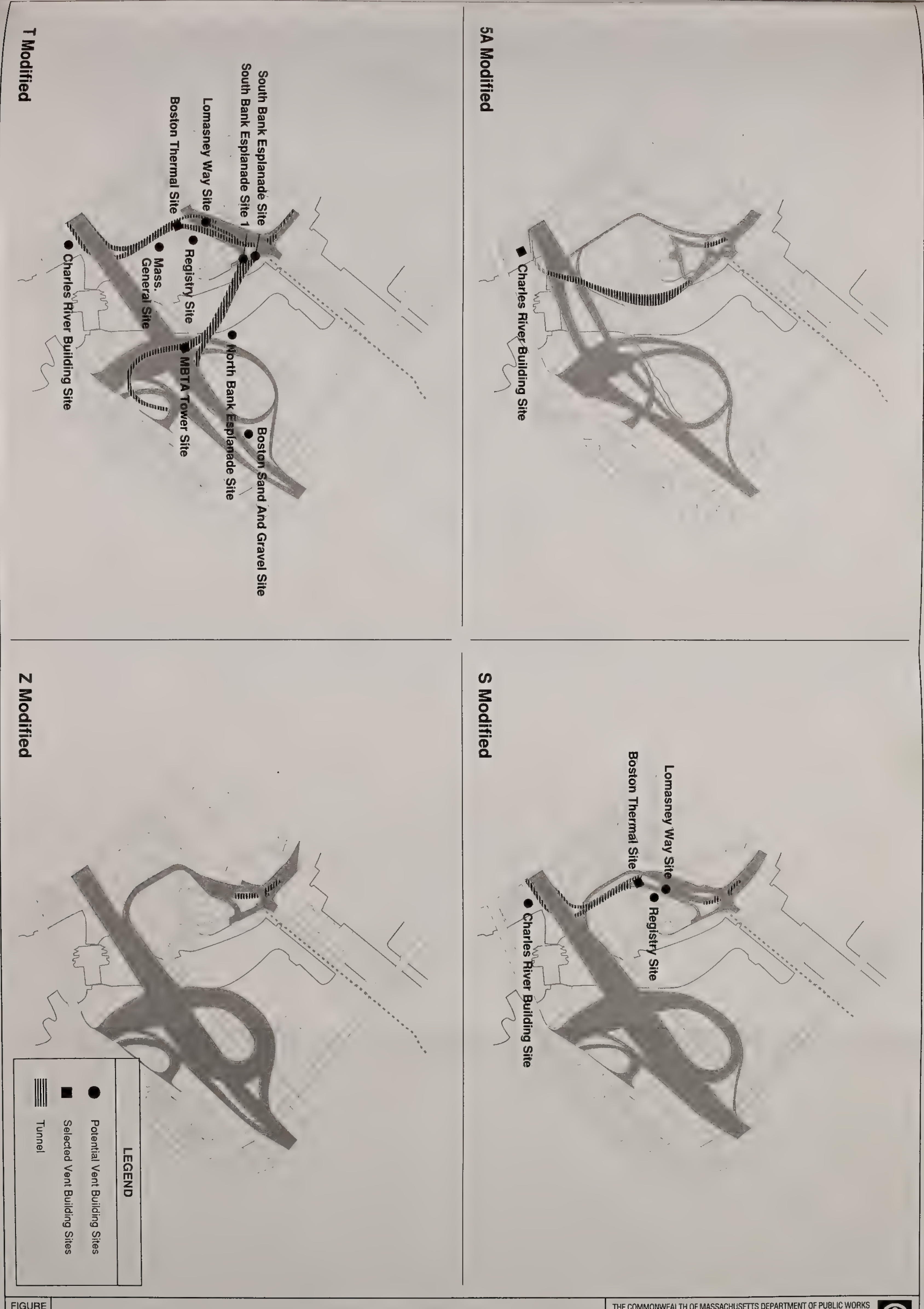
T Modified
South Bank Esplanade Site
South Bank Esplanade Site 1
Lomasney Way Site
Boston Thermal Site
Registry Site
Mass. General Site
Charles River Building Site
North Bank Esplanade Site
MBTA Tower Site
Boston Sand And Gravel Site
5A Modified
Charles River Building Site
Z Modified
S Modified
Lomasney Way Site
Boston Thermal Site
Registry Site
Charles River Building Site
LEGEND
● Potential Vent Building Sites
■ Selected Vent Building Sites
Tunnel

FIGURE
1.26

Vent Building Locations For 5A Modified, S Modified, T Modified, And Z Modified

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

The size and configuration of these sites would be sufficient to locate a ventilation building. Specific impacts at each site are listed below.

Two potential sites on the future south bank Esplanade were identified for ventilation buildings, one on top of the tunnel section and one immediately east of the tunnel. Both sites are located within planned MDC parkland, and a ventilation building would have a substantial adverse impact on the future parkland. Construction could require some fill in the Charles River.

The future north bank Esplanade (as proposed by MDC) site could require some fill in the Charles River, and the project construction schedule could be extended up to 2 years (due to construction staging considerations).

The MBTA Tower A site is owned by the Commonwealth of Massachusetts, and administered by the Department. No fill would be required in any water body. Construction of a ventilation building in this location (over the tunnel section and between two active viaduct structures) could potentially extend the project construction schedule up to 6 months due to complicated construction phasing and difficult access.

Construction of a ventilation building on the Boston Sand & Gravel (BSG) site would require a partial taking of BSG property including essential elements of the material handling and concrete production facilities. There would be no effect on the overall project construction schedule. No fill would be required in any water body.

Based on this analysis, it is recommended that the second ventilation building for T Modified be located at the MBTA Tower A site, even though the construction schedule could be extended by as much as 6 months. There would be no additional displacement or relocation necessary; construction on the site would not have an impact on any known cultural resources or parklands; and no fill would be required in any water body or designated tidelands. Because the ventilation building would be located between two elevated roadway sections, the urban design impacts would be minimal.

Option Z Modified. No ventilation buildings would be required with this option because there are no roadway sections in tunnel.

1.6.2 Potential Bridge Design Modifications

As design of the bridges over the Charles River has become more detailed, a number of design modifications have been discussed to both reduce the number of piers in the river and improve bridge aesthetics of the Charles River bridge. Each option has been evaluated with respect to its impact on these two issues, as well as its technical feasibility and cost implications. Work to date has narrowed the possibilities to the two options described below.

Option A - Cable-Stayed Guideline Bridges. In this option a cable-stayed design would be used for the I-93 north- and southbound mainline bridges and two conventional, below-deck, box girder ramp bridges would be used for the Causeway Street to I-93 northbound ramp to the east and the two-level Storrow Drive connector ramp system (in the case of Z Modified and S Modified) to the west. In order to obtain adequate clearances between bridge structures for the pylons for the cable-stayed structures, a four-bridge alignment with the eastern ramp on an independent structure would be required. In addition, a 30- to 50-foot shift to the east of the northbound mainline and ramp would have to be made.

The cable-stayed bridge design, in addition to improving the aesthetics of the crossing by providing a graceful and attractive structure, also enables a reduction in the number of piers in the river (see Figure 1.20) -- from 17 to 8 (for Z Modified or S Modified). Option A is feasible for all options except 5A Modified because of the curvilinear alignment of I-93 northbound.

Option 1B - Increased Span/Reduced Number of Piers. In this option, the alignment of the three-bridge configuration (in the case of S Modified and Z Modified) or two-bridge configuration (in the case of T Modified) remains the same. The number of piers in the river, however, is reduced by increasing the spans from 250 feet to 350 feet, and by reconfiguring the location of the piers. Although this is an attractive modification to the 17-pier configuration characteristic of S Modified or Z Modified, additional refinements are still required. The clearance over the channel does not, as presently defined, provide the 23-foot clearance required for MDC operations of the recreation locks. A 30 foot clearance is provided for the navigation channel. Solutions entailing reconfiguration of the pier locations and modification to the depth of structure are currently being considered.

1.6.2(a) Impacts Of Bridge Design Modifications

Bridge Design Modifications: Visual Impacts. The reduction in piers with either a cable-stayed or haunched girder design will lessen the visual clutter in the Charles River. The longer spans will provide better views and allow for a more graceful design than with the Proposed Action 17-pier bridges.

The cable-stayed bridge design will require construction of the northbound on-ramp as a separate bridge, resulting in four bridges and a wider river crossing. The large superstructure required for the cable-stayed bridge will be approximately 400 to 450 feet high. The two outside bridges in this design modification would be a haunch girder of classical design.

Land Use Impacts. Option 1B uses the same alignments as indicated for the base options and would, therefore, have no additional land impacts beyond those already described for the four options in Section 1.4.6.

Option A requires a shift of approximately 50 feet to the east of the northbound mainline in order to accommodate the width of the pylons. This shift would result in an overall widening of the river crossings with increased space between structures. The result of this widening would be to cast shadows over an additional portion of the Paul Revere Landing Park's north and south banks.

Environmental Impacts. A cable-stayed bridge option or a reduction in the number of piers in the river would potentially decrease impacts to aquatic resources and water quality, since fewer piers, and hence less dredging and dewatering, would be required during and after construction. Impacts to the benthic and fish habitats would be decreased as would turbidity levels during construction. A cable-stayed bridge option may require more bridge surface area over the water and resulting increased shading, which would affect primary production in the Charles River. Increased coverage could also have impacts on the pedestrian environment.

Construction Impacts. Option 1B has no substantial effect with respect to constructibility, other than reducing the number, but increasing the size, of the pier footings to be constructed in the river. Increasing the span lengths may also require larger floating erection equipment, depending on the type of structure ultimately designed and selected for construction.

Option A has somewhat greater constructibility impacts. Because the bridges are separated and therefore occupy a greater overall width, the ramp bridge structure is shifted to a location that conflicts with the existing I-93 bridge. Construction of this fourth bridge in Z Modified and S Modified, or third bridge in T Modified, would have to be delayed until the new mainline bridges were placed in service and the existing bridge removed. Other than extending the duration of work in the area, there would be no major impacts associated with this phasing. Connections from the independent northbound ramp system cannot be completed, regardless of which option is selected, until the new mainline is open and the existing mainline is removed, because of conflicts with the existing mainline viaduct structure in Charlestown. During the period when the new mainline is open but the northbound ramps are not, northbound traffic entering at Causeway or Traverse Street will be able to go to Route 1 only. Traffic destined for I-93 northbound would have to use the North Washington Street bridge and ramps from Charlestown.

Construction of the mainline bridges in a cable-stayed design would entail a somewhat different type of construction procedure than in the classic bridge design. The large towers of the cable-stayed bridge probably would be constructed with a climbing form system. Segments of the bridge roadway could be fabricated in the vicinity or barged in from a remote fabrication site. Roadway segments would then be erected in a balanced cantilever sequence by either a tower mounted crane or barge mounted erection equipment.

Foundations for the towers would be substantially larger than the single piers in the classical bridge option; however, construction methods would be essentially the same. Foundation work would occur inside steel sheetpile cofferdams and would entail dredging, pile driving and concrete placing. The phasing and sequencing of construction work in the cable-stayed option, as in the classic bridge option, would be developed to minimize impacts to navigation. Methods that minimize water quality impacts would also be implemented.

1.7 COMPARISON OF OPTIONS

This section of the chapter provides two basic sets of information. First, summary tables present information on the four roadway options relative to five topics:

- o The roadway characteristics of each option - Table 1.20
- o The operational impacts of each option - Table 1.21
- o The environmental impacts of each option - Table 1.22
- o The construction impacts/issues of each option - Table 1.23
- o The evaluation of the options relative to design objectives - Table 1.24

Table 1.20

COMPARISON OF ROADWAY CHARACTERISTICS BY ROADWAY LINK

Roadway Element	5A Modified	S Modified	T Modified	Z Modified
I-93 NB to Storrow Drive	Tunnel on south bank of Charles	Tunnel behind North Station	Tunnel behind North Station	I-93 over Charles River to viaduct behind North Station to Storrow Drive
I-93 SB to Storrow Drive	Bridge over Charles to viaduct behind North Station	Bridge over Charles to viaduct behind North Station	Tunnel under Charles direct to Storrow Drive	Bridge over Charles to viaduct behind North Station
I-93 NB to Route 1	Left-hand ramp from mainline to CANA ramps	Right-hand ramp from mainline to CANA ramps	Right-hand ramp from mainline to CANA ramps	Right-hand ramp from mainline to CANA ramps
I-93 NB to Route 1	Right-hand ramp from mainline to CANA ramps	Right-hand ramp from mainline to CANA ramps	Right-hand ramp from mainline to CANA ramps	Right-hand ramp from mainline to CANA ramps
I-93 NB to local streets and Charlestown	Off at Rutherford Ave. or Leverett Circle	Off at Rutherford Ave. or Leverett Circle	Off at Rutherford Ave. or Leverett Circle	Off at Rutherford Ave. or Nashua Street via bridges over Charl
I-93 SB to local streets	Ramp to Causeway Street	Ramp to Causeway Street	Ramp to Causeway Street	Ramp to Nashua Street
Storrow Drive to I-93 NB	Viaduct behind North Station to bridge over Charles to left-hand merge	Viduct behind North Station to bridge over Charles to left-hand merge	Tunnel under Charles to right-hand merge	Viaduct behind North Station to bridge over Charles to left-hand merge
Storrow Drive to I-93 SB	Tunnel on south bank of Charles	Tunnel behind North Station	Tunnel behind North Station	Viaduct behind North Station to bridge over Charles to I-93 mainline
Storrow Drive to Route 1	Viaduct behind North Station to bridge over Charles to left-hand ramp to CANA	Viaduct behind North Station to bridge over Charles to CANA	Tunnel under Charles directly to Route 1	Viaduct behind North Station to bridge over Charles to CANA

Table 1.20 (Cont.)

COMPARISON OF ROADWAY CHARACTERISTICS BY ROADWAY LINK

Roadway Element	5A Modified	S Modified	T Modified	Z Modified
Route 1 to Storrow Drive	CANA to bridge over Charles to viaduct behind North Station	CANA to bridge over Charles to viaduct behind North Station	Tunnel under Charles directly to Storrow Drive	CANA to bridge over Charles to viaduct behind North Station
Local streets to I-93	Ramps from Causeway Street, Rutherford Avenue, Leverett Circle	Ramps from Causeway Street, Rutherford Avenue, Leverett Circle	Ramps from Causeway Street, Rutherford Avenue, Leverett Circle	Ramps from Traverse Street, Rutherford Avenue, Leverett Circle

Source: Bechtel/Parsons Brinckerhoff

Table 1.21

COMPARISON OF TRAFFIC OPERATIONS

Operation	5A Modified	S Modified	T Modified	Z Modified
Weave - Sumner on to Storrow Drive off	Mainline weave, 750 feet on 5.3% upgrade	Mainline weave, 750 feet on 5.3% upgrade	Mainline weave, 750 feet on 5.3% upgrade	Distance on-ramp to off-ramp, 2,300 feet on 5.3% upgrade
Weave - Storrow Drive on to Callahan off	Mainline weave, 1,500 feet	Mainline weave, 850 feet	Mainline weave, 850 feet	Distance on-ramp to off-ramp, 2,600 feet
Weave - Storrow Drive to I-93 NB and Rte 1	Mainline weave, 1,400 feet	Weave eliminated	Mainline weave eliminated, ramp weave in tunnel of 1,000 feet	Mainline weave eliminated, ramp weave in tunnel of 1,800 feet
Weave - I-93 SB and Rte 1 to Storrow Drive	Mainline weave, 1,300 feet	Mainline weave eliminated, ramp weave of 1,800 feet	Weave eliminated	Mainline weave eliminated, ramp weave of 1,600 feet
Local street operations	Worst	Better than T Modified	Better than 5A Modified	Best
I-93 mainline travel time in AM	Inferior to Z Modified	Inferior to Z Modified	Inferior to Z Modified	Best
I-93 mainline travel time in PM	Inferior to Z Modified	Marginally inferior to Z Modified	Marginally in-inferior to Z Modified	Best
Storrow to I-93 SB travel time	Marginally inferior to Z Modified	Inferior to Z Modified	Inferior to Z Modified	Best
I-93 NB to Storrow travel time	Inferior to T Modified	Inferior to T Modified	Best	Marginally inferior to to Modified
Vehicle Hours Travelled (VHT)	634,000	580,000	595,000	619,000

Table 1.21

COMPARISON OF TRAFFIC OPERATIONS

Operation	5A Modified	S Modified	T Modified	Z Modified
Vehicle Miles Travelled (VMT)	5,202,000	5,200,000	5,180,000	5,231,000
Offpeak highway operations/safety issues	Left-hand exit at top of 5.3% upgrade; short weave section I-93 NB	Short weave sections on I-93	Short weave sections on I-93	Marginally higher VMT

Source: Bechtel/Parsons Brinckerhoff

Table 1.22

COMPARISON OF LONG-TERM ENVIRONMENTAL IMPACTS

Operation	5A Modified	S Modified	T Modified	Z Modified
Pedestrian env. on Causeway Street	Serious pedestrian vehicular conflict at project ramps	Serious pedestrian vehicular conflict at project ramps	Serious pedestrian vehicular conflict at project ramps	No ramps to/from Causeway Street
Pedestrian env. on south banks of Charles	Major impacts from tunnels and ramps on river banks, vent bldg	Bridge wider than T Mod, vent bldg	Bridge narrower than other options, vent bldg	Bridge wider than T Mod, no vent bldg
Pedestrian env. on north bank of Charles, west of I-93 mainline	Ramp adjacent to pedestrian path	Ramp adjacent to pedestrian path	Ramp adjacent to pedestrian path	Ramp above pedestrian path
Noise	Marginally worse , than S & T Mods	Slightly better than 5A & Z Mods	Slightly better than 5A & Z Mods	Marginally worse than S and T Mods
Water quality	Least increase in pollutant loadings due to runoff	Marginally less impact than Z Mod	Less impact than Z Mod	Some increases in pollutant loadings due to runoff
Vegetated wetland filled	0.01 acre	0.44 acre	0.44 acre	0.44 acre
Aquatic habitat lost	1.9 acres	0.58 acre	0.57 acre	0.58 acre
Shading of water surface	2.69 acres	4.76 acres	4.65 acres	5.66 acres
4(f) Impacts, Paul Revere Park, South Side	Largest area taken (0.9 acre), bridge over dam	Greater area taken (0.8 area), bridge upstream of dam	Greater area taken (.77 acre), bridge upstream of dam	Least area taken (0.69 acre), bridge upstream of dam
4(f) Impacts, Paul Revere Park, North Side	Overshadowed by new bridges	Improved, new bridges further than present ones	Improved, new bridges further than present ones	Improved, new bridges further than present ones
4(f) Impacts, Leverett Circle/ Storrow Drive	Greatest impact on Esplanade; 0.2 acre used north of Storrow Drive	Small area changed from roadway landscaping to roadway (net 0.3 acre)	Small area changed from roadway landscaping to roadway (net 0.58 acre)	Small area changed from roadway landscaping to roadway (net 0.3 acre)

Table 1.22 (Cont.)

COMPARISON OF LONG-TERM ENVIRONMENTAL IMPACTS

Operation	5A Modified	S Modified	T Modified	Z Modified
Land use - North Station area	Conflicts with Boston Garden, ramps impact Causeway St.	Conflicts with Boston Garden, ramps impact Causeway St.	No viaducts behind North Station, improves env. for development, tconflicts with Boston Garden ramp impacts on Causeway St.	Best pedestrian env. on Causeway St., accommodates planned development
Land use - Cambridge	Ramps further from North Point than Z Mod, S Mod	Ramps closer to North Point than 5A Mod	Ramps further from North Point than Z Mod, S Mod	Ramps highest and closest to North Point
Visual impacts from Leverett Circle/Nashua Street Area	Loop ramps dominant; boat sections disrupt pedestrian env. on south bank	Marginally less impact than Z Mod; south bank not disrupted; vent bldg south of 100 Nashua St.	Loop ramps marginally denser than 5A Mod; south bank not disrupted; vent bldg south of 100 Nashua St.	Loop ramps and bridges highest, closest, and most dense; south bank not disrupted, south bank elements least visible; no vent building
Visual impacts from North Point site, Cambridge	Loop ramps and bridges dominant	Loop ramps closer and denser than T Mod; closest bridge is double-decked	Loop ramps similar to 5A Mod; vent bldg inside loop ramps	Loop ramps highest, closest, and most dense; no vent bldg; closest bridge is double-decked; greatest morning shadows
Visual impacts from Paul Revere Park, north side	Bridge overhead, but visual continuity to upstream destinations; afternoon shadows	Bridges well upstream; visual continuity marginally less than T Mod	Bridges well upstream; visual continuity upstream retained but less than 5A Mod	Bridges well upstream; visual continuity marginally less than S Mod and T Mod
Visual impacts from Charlestown residential area	Viaducts create visual barrier	Between T Mod and Z Mod in appearance	Similar to 5A Mod but more dense	Similar to T Mod but higher and more dense

Table 1.22 (Cont.)

COMPARISON OF LONG-TERM ENVIRONMENTAL IMPACTS

Operation	5A Modified	S Modified	T Modified	Z Modified
Relocation impacts[1]	Charles River Bldg - 100-ft bay taken	Boston Sand & Gravel - full or major taking; Boston Thermal steam plant taken; B&M North Terminal possible major impact	Boston Sand & Gravel - partial taking; Boston Thermal steam plant taken; B&M North Terminal taken	Boston Sand & Grave - full or major partial taking; B&M Nort Terminal possible maj impact
4(f) Historical Impacts	Charles River Bldg - 100-ft bay removed; Causeway/ North Washington Streets District impacted	100 Nashua Street affected: Causeway /North Washington Streets District impacted	100 Nashua Street affected; Causeway /North Washington Streets District impacted	No adverse impacts

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[1] All options would take private parking on Lovejoy Wharf and behind Boston Garden (North Station Auto Park Corp.) and Anelex Building

Source: Bechtel/Parsons Brinckerhoff

Table 1.23

COMPARISON OF CONSTRUCTION PERIOD IMPACTS

Operation	5A Modified	S Modified	T Modified	Z Modified
Storrow Drive to I-93 NB connection	Loss of connection for 2 years	No loss of connection	No loss of connection	No loss of connection
I-93 NB to Storrow Drive connection	Loss for 3-5 mos.	Loss for 3-5 mos.	Loss for 3-5 mos.	No loss of connection
Storrow Drive WB	Some impacts	Some impacts	Major impacts	Some impacts
Storrow Drive EB	Minor	Some impacts	Major impacts	Some impacts
Leverett Circle Operations	Some disruption	Some disruption	Major detours 1-2 years	Some disruption
Impact to commuter rail service	Possible loss of service for some months, greatest impact of all options	Not likely to require significant loss of service	Difficult to construct without some loss of service	Not likely to require any significant loss of service
Impact to Green Line service	Can be coordinated with MBTA's Green Line reconstruction (MBTA will require 6 mos. loss of service)	Difficult to coordinate with MBTA's Green Line reconstruction; may also require further loss of service (MBTA will require 6 mos. loss of service)	Difficult to coordinate with MBTA's Green Line reconstruction; may also require further loss of service (MBTA will require 6 mos. loss of service)	Can be coordinated with MBTA's Green reconstruction (MBTA will require 6 mos. loss of service)
Ventilation structure construction	1 structure, moderate difficulty	1 structure, moderate difficulty	2 structures, 1 moderate difficulty, 1 high difficulty	No ventilation structures
Temporary viaduct construction	Requires 2-level viaduct behind N Station	Requires 2-level viaduct behind N Station	None required	Requires 2-level viaduct behind N Station
Noise and Vibration	Moderate impact	Moderate impact	Somewhat worse than other options due to tunnel work	Moderate impact

Table 1.23 (Cont.)

COMPARISON OF CONSTRUCTION PERIOD IMPACTS

Operation	5A Modified	S Modified	T Modified	Z Modified
Wetlands/Water Quality	Somewhat worse than S and Z Mod	Some impacts to Millers & Charles	Worst of all options, potentially substantial impacts	Some impacts to Millers & Charles
Navigation	Somewhat worse than S and Z Mod	Moderate	Worst	Moderate
Boston Garden/ North Station dev.	Requires design modifications	Requires design modifications	Requires design modifications	No impact
Spaulding Rehabilitation Hospital	Has impacts on Hospital	No impact	No impact	No impact
Leverett Circle/ Storrow Drive	Major roadway disruption; permanent and temporary use of land north of Storrow.	Temporary eastbound roadway disruption; no impact on Esplanade.	Greatest roadway disruption east- and westbound; temporary use of land north of Storrow for tunnel connection.	Temporary eastbound roadway disruption; no impact on Esplanade.
Proposed MDC Nashua Street Park	Precludes waterfront park	No impact	Must delay park until project tunnels are complete	No impact
Proposed MDC GSA Park Site	No impact	No impact	Disruption by graving basin and dredging	No impact
Paul Revere Landing Park, south bank	Major disruption of access	Some disruption of access	Some disruption of access	Access maintained to most of park
Paul Revere Landing Park, north bank	Park remains closed throughout construction	Majority of park can be reopened prior to completion of construction	Majority of park can be open to public prior to completion of construction	Majority of park can be open to public prior to completion of construction
Overall construction duration impacts	None	None	Delays overall project 6-12 mos.	None
Degree of difficulty of construction	Moderate	Moderate	High	Moderate

Table 1.24

EVALUATION OF OPTIONS RELATIVE TO DESIGN OBJECTIVES

Operation	5A Modified	S Modified	T Modified	Z Modified
Provide all hwy and local street connections	Yes	Yes	Yes	Yes
Achieve necessary mainline design speed	Yes	Yes	Yes	Yes
Weave - Sumner on to Storrow Drive off	Mainline weave, 750 feet on 5.3% upgrade	Mainline weave, 750 feet on 5.3% upgrade	Mainline weave, 750 feet on 5.3% upgrade	Distance on-ramp to off-ramp, 2,300 feet on 5.3% upgrade
Weave - Storrow Drive on to Callahan off	Mainline weave, 1,500 feet	Mainline weave, 850 feet	Mainline weave, 850 feet	Distance on-ramp to off-ramp, 2,600 feet
Weave - Storrow Drive to I-93 NB and Rte 1	Mainline weave, 1,400 feet	Weave eliminated	Mainline weave eliminated, ramp weave in tunnel of 1,000 feet	Mainline weave eliminated
Weave - I-93 SB and Rte 1 to Storrow Drive	Mainline weave, 1,300 feet	Mainline weave eliminated, ramp weave of 1,800 feet	Weave eliminated	Mainline weave eliminated, ramp weave of 1,600 feet
Maintain all major traffic connections during construction	Storrow to I-93/1 cutoff for 2 yrs; loss of I-93N to Storrow for 3-5 mos.	Loss of I-93 N to Storrow 3-5 for mos.	Loss of I-93 N to Storrow for 3-5 mos.	Yes, all connections maintained
Minimize impacts to CANA	Least impact	Greatest impact	Moderate impact	Greatest impact
Minimize open space and parkland impacts, south bank of Charles, west of MBTA Bridge	Very significant adverse impacts to proposed parkland	No impacts	Construction impacts	No impacts

Table 1.24 (Cont.)

EVALUATION OF OPTIONS RELATIVE TO DESIGN OBJECTIVES

Operation	5A Modified	S Modified	T Modified	Z Modified
Minimize impacts to Paul Revere Landing Park, south side	Access impacts to existing park	Access impacts to existing park	Access impacts to existing park	Beneficial to existing park
Minimize impacts to:				
North bank of Charles, west of I-93 bridges	Minor adverse impacts to proposed parkland	Major adverse impacts to proposed parkland	Moderate adverse impacts to proposed parkland	Greatest adverse impacts to proposed parkland
Paul Revere Landing Park, north side	Moderate adverse impacts to existing and proposed parkland	Minor impacts to existing and proposed parkland	Minor impacts to existing and proposed parkland	Minor impacts to existing and proposed parkland
Boston Sand & Gravel	Minimal impacts	Full or major partial taking	Partial taking	Full or major partial taking
Boston Thermal	No impact	Taken	Taken	Minor impact
MWRA pumping Station	No impact	Some impacts	No impacts	Most impacts
Boston Garden development	Requires major redesign of proposed development	Requires major redesign of proposed development	Requires major redesign of proposed development	No impact on proposed development
Commuter Rail	Major disruption during construction	Some disruption during construction	Some disruption during construction	Least disruption during construction
MBTA Green Line	No service curtailment	Some service curtailment during construction	Some service curtailment during construction	No service curtailment

Source: Bechtel/Parsons Brinckerhoff

These tables provide very brief summaries of the detailed analyses provided earlier in this chapter. They include only a small portion of the information produced in the analysis. In some cases relative ranking of impact is included.

Following the tables is a summary of findings for the Area North of Causeway Street roadway options.

1.7.1 Summary Of Findings On Selected Key Issues

Weighing the information presented in this chapter is complicated by the variety of issues to be considered and the differences in impacts. The following summary addresses those four items which seem to emerge as the most critical issues.

- Long-term traffic operations
- Impacts on land use in the North Station/Bulfinch Triangle area
- Impacts on open space and parks in the Lower Charles River area
- Construction period impacts

Long-Term Traffic Operations. Each of the options developed since the FEIS/R was found to have the most favorable conditions with respect to at least one of the variables that were studied for traffic operations. Z Modified would have the best quality of traffic flow at signalized intersections, fastest mainline and connector speeds, the shortest queue lengths, and the fewest mainline weaving sections -- all of which would be more than 1,000 feet long. In other respects, Z Modified would operate at least as well as the other options. Option Z Modified has slightly higher VMT and VHT than the other options. These indicators are higher because option Z Modified has been designed to create a longer distance between critical on- and off-ramps, and thus make travel on the mainline safer. On balance, Z Modified provides the best traffic operations.

Impacts On Land Use In The North Station/Bulfinch Triangle Area. Option T Modified and option Z Modified each have one clear advantage in this part of the City. T Modified has no viaduct ramps and therefore will leave the surface untouched by major roadway components. This would improve the pedestrian environment (and potentially, if subsurface conflicts can be avoided, enhance the development climate) in the area between North Station and the Charles River, an area presently occupied entirely by railroad tracks and parking lots.

Z Modified has no ramps to Causeway Street and therefore provides a safer and more attractive pedestrian environment on Causeway Street and better connections between Causeway Street and the Charles River dam. As a result of having no ramps to and from Causeway Street, local street traffic operations in this area will be significantly better with Z Modified than with the other options. This will enhance the area's environment for both occupants of commercial space and visitors coming to Boston Garden.

Options T Modified, 5A Modified, and S Modified are incompatible with the proposed plans for the Boston Garden. The I-93 to Storrow Drive tunnels are in conflict with the building's foundations and the Causeway Street off-ramp unacceptably reduces the area available for service and emergency access, patron egress and garage access/egress. These options would require only minor modifications in the MBTA underground garage, now under construction. In addition, they also require the taking of the Boston Thermal building. Options 5A Modified and S Modified have the land use disadvantages of both T Modified and Z Modified without any of the advantages. On balance, option Z Modified has better impacts on the North Station area.

Impacts On Open Space And Parks In The Lower Charles River Area. The differences in impacts on open space and parks can be described for four distinct areas:

- Area 1 - South bank of the Charles: designated MDC Nashua Street Park and Leverett Circle
- Area 2 - South bank of the Charles: existing Paul Revere Landing Park and connection to Causeway Street
- Area 3 - North bank of the Charles: proposed open space/park improvements west of the (proposed) new I-93 bridges
- Area 4 - North bank of the Charles: existing Paul Revere Landing Park and walkway on the Charles River dam

Area 1: Options S Modified, T Modified, and Z Modified would have very minor long-term impacts in this area. Option 5A Modified would preclude the use of the banks of the Charles River (by the placement of open boat section ramps) and would thus have substantial negative impacts on this proposed open space.

Area 2: All of the options require some takings in this area (Z Modified takes the least; 5A Modified the most). Option Z Modified allows wider, and potentially better, pedestrian connections to be made between the park and Causeway Street (because there are no highway ramps at Causeway Street in this option). Option Z Modified also allows the creation of a new park where the pedestrian connection reaches Causeway Street and has the safest pedestrian conditions on Causeway Street.

Area 3: In this area of proposed landscaping, pedestrian and bicycle paths, and waterfront improvements (providing open space connections on land acquired for the highway projects), option 5A Modified would have the least additional impact on the current specific CANA landscape plan. Option Z Modified would have the greatest impact, with the greatest coverage by highway ramps. Option S Modified would be similar in impact to Z Modified, while T Modified would be in between S Modified and 5A Modified in coverage.

Area 4: Option 5A Modified (due to its split bridge alignment) would pass directly over the locks of the Charles River dam and a corner of the existing park, limiting expansion of the park. Options S Modified, T Modified, and Z Modified would have lesser visual impacts on the park, would pass upstream of the locks, and would permit future expansion of the north bank park to nearly twice its current area.

Summary: Overall, option 5A Modified is the worst of the options with respect to impacts on open space and parkland. Options T Modified and Z Modified each are better than the others in some respects. In connection with planning for the project, the Department is proposing substantial mitigation throughout the Lower Charles River area (see Section 1.8). These mitigation measures would include development of land now owned by the Department and the MDC as parkland, and assistance in improvements to other land which may be acquired at a later date, and the potential relocation of the Millers River.

Construction Period Impacts. Options 5A Modified and T Modified each have substantial construction period disadvantages relative to the other options. Option 5A Modified would result in the loss of the Storrow Drive to I-93 northbound and Route 1 connections for a period of 2 years, which would create a major traffic problem. Options 5A Modified, S Modified, and T Modified would all require detours for 3 to 5 months to allow the connection from I-93 northbound to Storrow Drive to be completed. Option Z Modified would not cause any major loss of service or major detours.

Option T Modified involves very difficult tunnel construction across the Charles River, which has the greatest construction period adverse impact on aquatic ecology and water quality, and would add 6 to 12 months to the project schedule. Option T Modified may also have impacts on the MBTA's commuter rail operations.

Of all the options, Z Modified has the least impact during construction.

1.7.2 Conclusion

Based on the comparison of the four key issues discussed above, and the entire analysis presented in this chapter, option Z Modified shows the greatest amount of benefit, tempered by its impacts on the proposed open space on the north bank of the Charles, west of the (proposed) new I-93 bridges. As described above, these open space impacts will be mitigated with a significant package of mitigation measures to be provided by the project (see Section 1.8 below which describes these mitigating measures). Once these mitigating measures are implemented, option Z Modified emerges as the most beneficial and least harmful option for achieving a satisfactory north of Causeway interchange.

1.8 PROPOSED MITIGATION MEASURES

The entire section of the Charles River between the Science Museum and the North Washington Street Bridge has been dominated by industrial and transportation uses for over a century. The Commonwealth and MDC have long had an objective of extending the Esplanade downstream from the Science Museum on both banks of the river. They have begun to implement that plan through the development of the New Charles River Dam, the walkway on the dam, the Paul Revere Landing park, the purchase of the GSA parcel, and the designation of the Nashua Street parcel for parkland. The reconstruction of the Artery provides an opportunity to advance this long-standing plan and establish a more compatible relationship between the transportation improvements and an improved park area along the river, mitigating the impact on the Charles River Dam and Paul Revere Landing and permitting the development of park resources along approximately 70% of the riverbanks in this area.

There are several purposes of mitigation in the Area North of Causeway Street. First, mitigation is intended to minimize direct harm to existing parkland properties and to ensure their continued functioning as parkland both temporarily and permanently. Second, because the Charles River crossing will be a visually dominant element throughout the area, the Department seeks to take advantage of all opportunities created by the project to mitigate visual impacts on existing and future parkland, private development, pedestrian paths and public facilities. The mitigation measures described here would help to mitigate visual impacts and to further and enhance parkland development on both sides of the river, integrating the Artery/Tunnel Project with future and existing parkland and providing usable pedestrian access routes. Because the Artery/Tunnel project affects the area in numerous locations, it is appropriate for the Department to work with the MDC and the Cities of Boston and Cambridge and other agencies and organizations toward an overall plan for the area which will integrate and coordinate mitigating measures with park development to best advantage and in a mutually consistent manner.

A third purpose is to integrate the Artery/Tunnel Project effectively with CANA project mitigation on the north bank of the Charles adjacent to the existing Paul Revere Park. This will require modification of the existing specific design concept for the land, which made no assumptions concerning a Charles River crossing improvement of any kind. However, the intent of those mitigation commitments, as adjusted to provide for the river crossing, will be honored by the Department and will be completed as part of the Artery/Tunnel Project.

Planning Concept. The parkland mitigation measures described below are intended to meet planning and design objectives of the MDC and other agencies and interest groups for park development and enhancement of the environment of the Lower Charles River. The primary objective is to extend the Esplanade along both banks of the river, filling an important gap in the MDC's Charles River park system, and to enhance the accessibility to the river from the adjacent neighborhoods in Charlestown, the North End and North Station, the West End and Cambridge. The Artery/Tunnel Project provides the opportunity to complete, or nearly complete, pedestrian/bicycle and landscape connections between important park resources upstream of the Museum of Science dam and downstream of the north Washington Street bridge. On the north bank it is possible to fully connect the Lechmere Canal Park/Esplanade through the project area to the Charlestown Navy Yard and on the south bank to provide all but the final connection across the railroad tracks between the Esplanade and the North End parks operated by the MDC and the City of Boston (see Figure 1.27).

This system of improvements is intended to facilitate completion of the MDC parkland system immediately after construction of the project, to treat the individual parkland components as a system, and to give a high priority to pedestrian and bicycle access around the Lower Charles River and connections to it from the Esplanade, Cambridge waterfront, Charlestown, North Station area, and the Boston Harborwalk.

The planning concept for the area is to create a park environment in the Lower Charles River which is the important transition zone between the Esplanade on the west and Boston Harbor on the east. While the planning and design theme for this zone would call on some of those area's characteristics, it would also have its own unique character. This would come mainly from the relatively small-scale, enclosed and urban nature of the space, and from the heavily transportation-oriented land uses through and bordering much of the area.

While this area will be a distinct zone in the entire Charles River parkland system, it will also be composed of a number of park nodes and landscaped connections, each with its own character and treatment. There are major nodes at either end of the zone: the former GSA site, and the expanded Paul Revere Landing Park on the north bank; and the Nashua Street parkland and Lovejoy Wharf on the south bank.

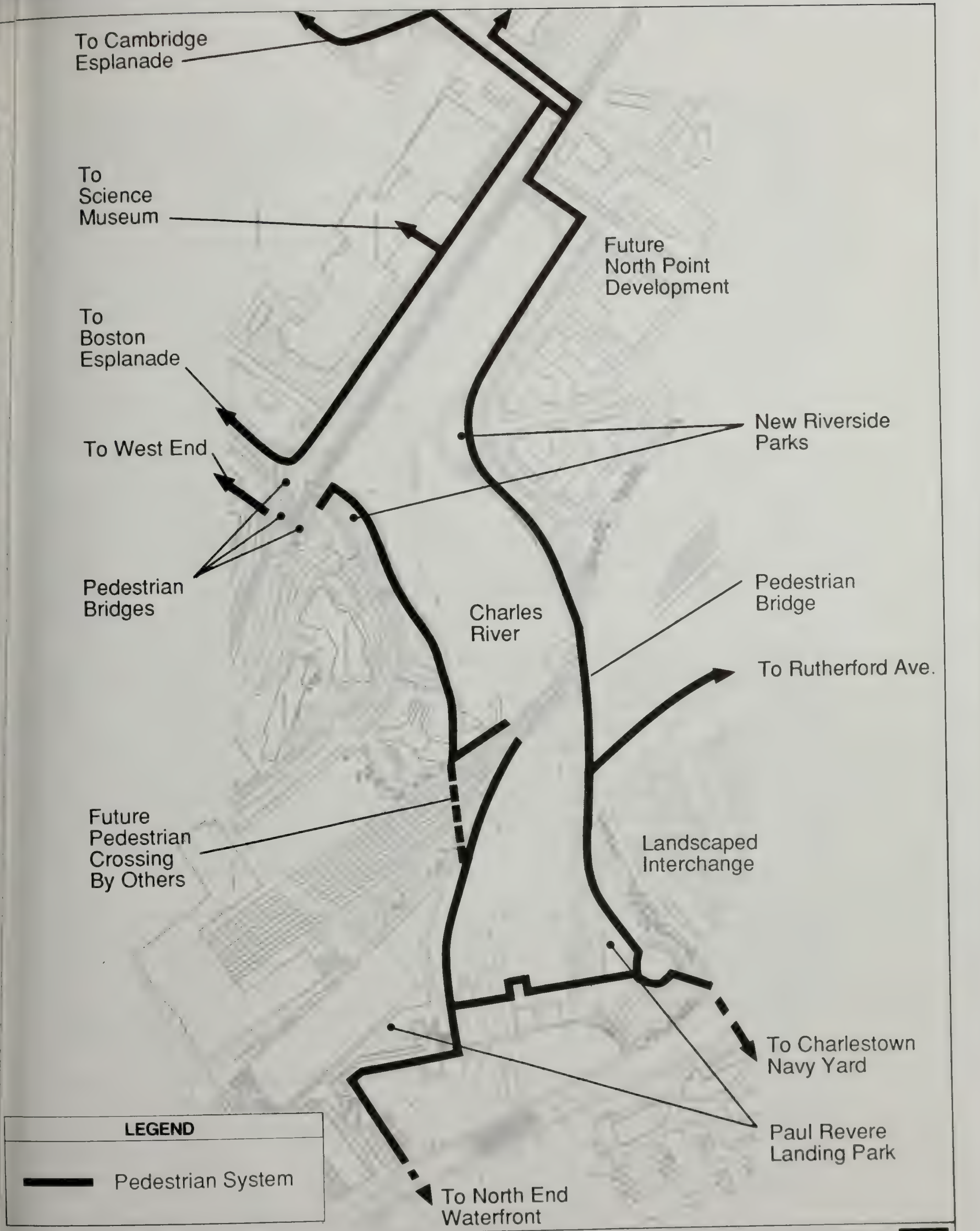


FIGURE 1.27

General Parkland Development Objectives, Area North Of Causeway Street

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 200 400 Feet
100 300

In view of historic uses in this area, an industrial and transportation theme might be considered as a unifying approach. It can be expected that the area will remain to some degree unlike any other along the Charles River. The area between the dams can act as an appropriate end to the Esplanade corridor by giving its terminal area a single image, common to both banks. Granite walls, pathways, and railings alongside the river can establish a strong linear dimension. Forming the transition between the Esplanade and Boston Harbor, some type of hard-edged urban treatment of both river edges might be carried downstream to the new dam. Identifying features from other areas along the Charles River could be integrated that suggest, perhaps, the original concept of the Esplanade. These features could include interpretive areas, monuments of dedication, open plazas, or open lawn areas. All in all, however, the theme of industry, transportation, and manmade environment should be portrayed, making the area a special distinguishable element in the Esplanade network.

Relationship To CANA Project Commitments. The Department has supported the objectives of the MDC to enrich the context of the existing parks in the area and strengthen pedestrian access to and through them. This commitment to MDC goals has been evident in the mitigation commitments of the CANA project documents and the 1985 Artery/Tunnel FEIS/R. It is continued here. Common to these measures to minimize harm are efforts to refine the design of highway improvements in any design option to reduce impacts to parklands, tidelands, wetlands, and areawide land use and aesthetics to the extent possible. The Department continues to be committed to supporting the MDC's areawide goals by assisting with the acquisition and development of parkland and the improvement for park use of Department land not needed for highway improvements.

Following the FEIS/R, CANA project coordination with the MDC continued in the context of application for a Chapter 91 license for use of former tidelands by CANA. The Department's assistance with the MDC's future park acquisition plans was identified as a means to mitigate the nonwater dependent use of tidelands by CANA. As a result, the Department agreed to go as far as possible toward satisfying the MDC's goals for future parkland acquisition on land available after completion of the highway projects. Specifically, in any option, continuous pedestrian access will be provided along the river through Department land and over the MBTA commuter rail tracks. Land under and around the bridges and elevated loop ramps will be conveyed to the MDC upon completion of both highway projects, some segments of which will be constructed concurrently.

In the roadway options considered for the Charles River crossing, continuous pedestrian access can be provided along the river as envisioned in the CANA Chapter 91 conditions. Land in the CANA construction area under and between the highway structures would be improved to different degrees by schemes 5A Modified, S Modified, T Modified, and Z Modified, and these schemes differ in their future aesthetic impacts on landscape improvements in this area. These impacts have been described in this chapter.

Proposed Postconstruction Mitigation Measures. Figure 1.27 shows the general parkland development objectives in the Lower Charles River area. Figure 1.28 shows the location of proposed mitigation measures and Figure 1.29 shows the illustrative parkland development concept for the Lower Charles River. These mitigation measures are extensive and are intended to lessen the overall visual impact of the large scale structures in this developing parkland area. [Construction period mitigation measures are described in Part III, Section 4(f) evaluation.]

As a matter of policy, the Department will construct park improvements on land owned by MDC or to be transferred to MDC in the future for parkland development of the lower Charles River. Because of the extent of the improvements proposed, the Department will work with the MDC to prepare a park development plan for the area in consultation with the Cities of Boston and Cambridge and other agencies and interest groups. For land not already publicly owned, the Department will assist the MDC in acquiring land or easements and will work cooperatively to provide design and construction services. The Department will continue to work with the MDC, Cities of Cambridge and Boston, and other interests to achieve the overall improvement of the Lower Charles River area.

The following is a list of specific mitigation measures that the Department is committed to implement to mitigate the permanent and temporary takings and adverse visual impacts of the project in the Lower Charles River. (Figure 1.28 shows the location of specific proposed mitigation measures in the area keyed to numbers listed below.)

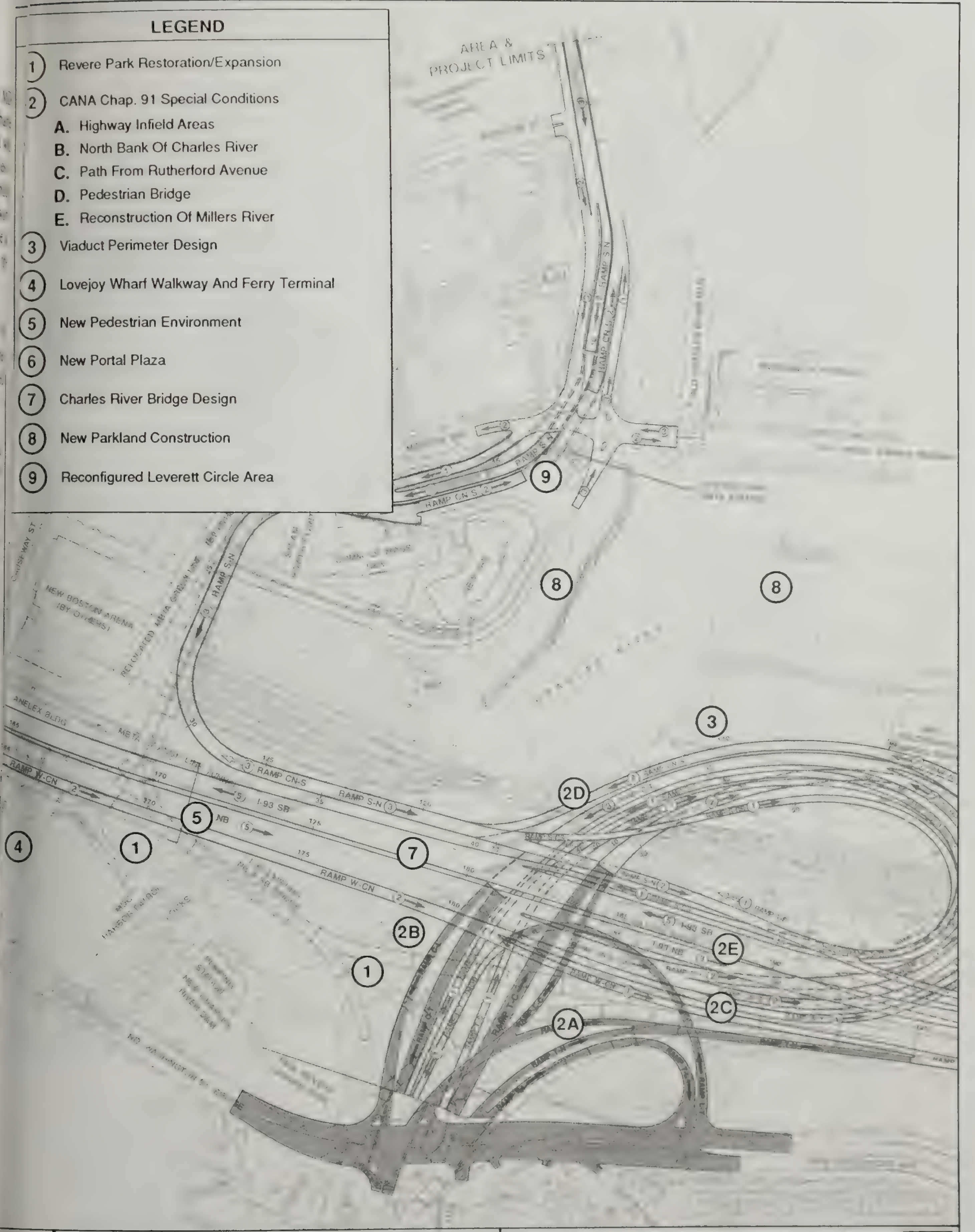
- o Paul Revere Landing Park (#1): The south bank portion of the Paul Revere Landing Park not permanently used by the project will be restored after construction. The minor reconfiguration that will occur in this area will maintain all previous park functions and enhance them, although 73 parking spaces will be displaced. On the north bank, the park will be expanded north and west to the CANA ramps and new bridges, completely relandscaped as a major element in the riverfront park system, and connected by landscaped walkways through the Chapter 91 area and to Charlestown.

- o CANA Chapter 91 Waterways License, Special Conditions (#2): The Chapter 91 conditions include: (a) landscaping and maintenance of highway infield areas; (b) landscaping, including pedestrian/bicycle path, along the north bank of the Charles River; (c) construction of landscaped pedestrian path from Rutherford Avenue to the Charles River; (d) construction of a pedestrian bridge over the MBTA commuter rail tracks; and (e) reconstruction of the Millers River and landscaping.

  Although the details of the Chapter 91 License conditions will require revision to accommodate replacement of the existing I-93 high-level bridge, the Department remains committed to the basic purpose of the CANA conditions. The Department will implement the CANA Chapter 91 mitigation measures listed in the preceding paragraph, as revised to be compatible with the Artery/Tunnel Project.

  This may include relocation of the Millers River (see Figure 1.30) to increase sunlight and to provide a boat landing ramp in the Millers River. The latter would require removal of the existing conduits at the Charles River Bank to allow boats to pass through. Parking areas for this use would also be provided east of the Millers River under the ramps. This would satisfy a long-standing objective of the MDC to provide a public boat landing. Alternatively, the Millers River could possibly be relocated east of I-93, passing through the expanded Paul Revere Landing Park as a new feature of the landscape.

- o Viaduct Design (#3): The structural design, placement of columns, lighting, and architectural treatment of perimeter facade, underside and columns will be done so as to be as compatible as possible with the park improvements, and to present an acceptable appearance to abutting uses in the North Point area of Cambridge and the Charlestown area bordering the ramps.


LEGEND
1 Revere Park Restoration/Expansion
2 CANA Chap. 91 Special Conditions
A. Highway Infield Areas
B. North Bank Of Charles River
C. Path From Rutherford Avenue
D. Pedestrian Bridge
E. Reconstruction Of Millers River
3 Viaduct Perimeter Design
4 Lovejoy Wharf Walkway And Ferry Terminal
5 New Pedestrian Environment
6 New Portal Plaza
7 Charles River Bridge Design
8 New Parkland Construction
9 Reconfigured Leverett Circle Area
AREA & PROJECT LIMITS
RAMP S-N
RAMP CN-S
RAMP CN-S 2
RAMP S-N
NEW BOSTON ARENA (BY OTHERS)
RELOCATED MBTA GREEN LINE
ANELEX BLDG
RAMP W-CN
RAMP CN-S
RAMP S-N
I-93 SB
NB
RAMP W-CN
I-93 NB
I-93 SB
9
8
8
3
2D
5
7
4
1
2B
1
2E
2C
2A

FIGURE

1.28

Location Of Proposed Mitigation Measures, Area North Of Causeway Street

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 100 200 400 800
FEET

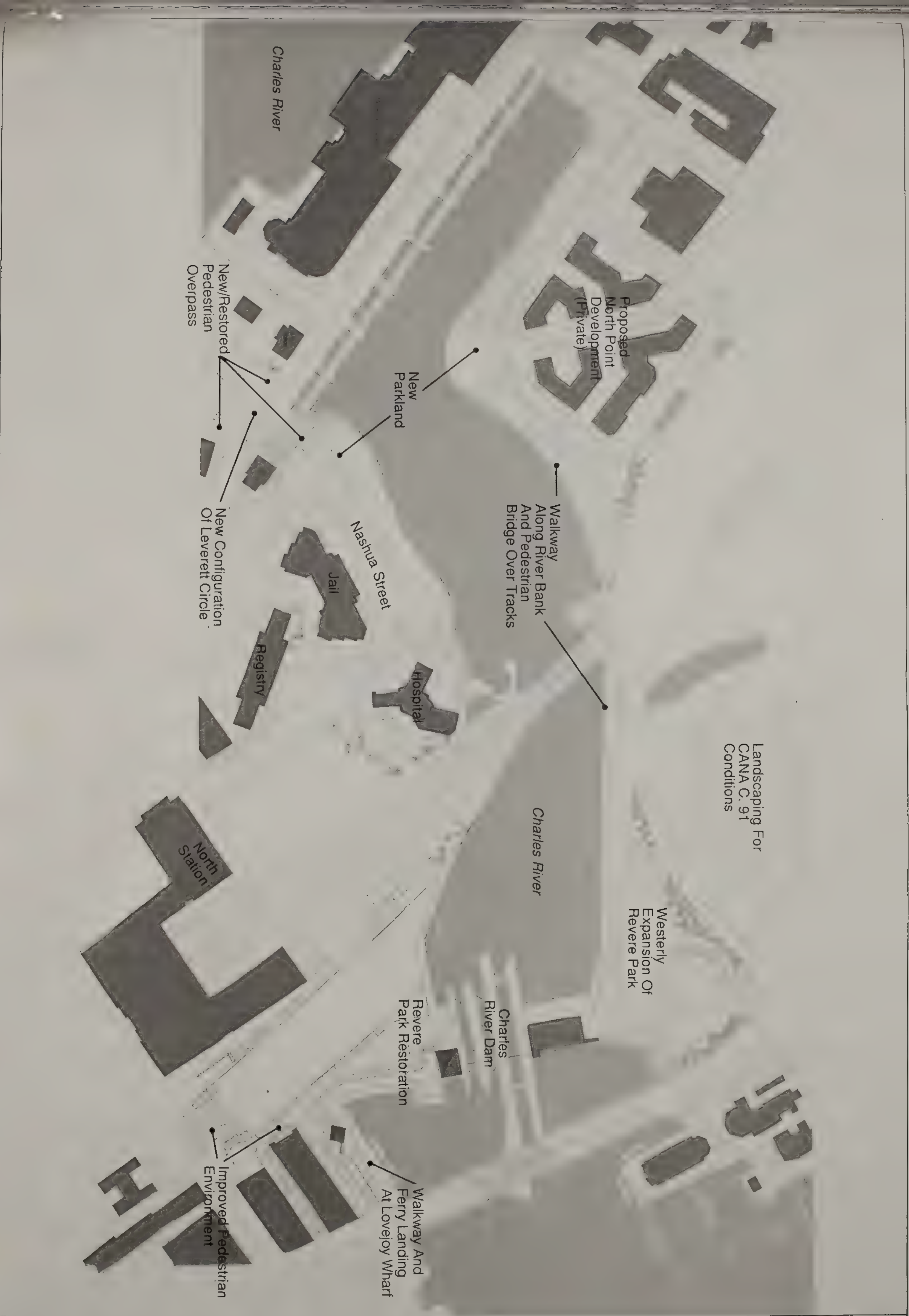
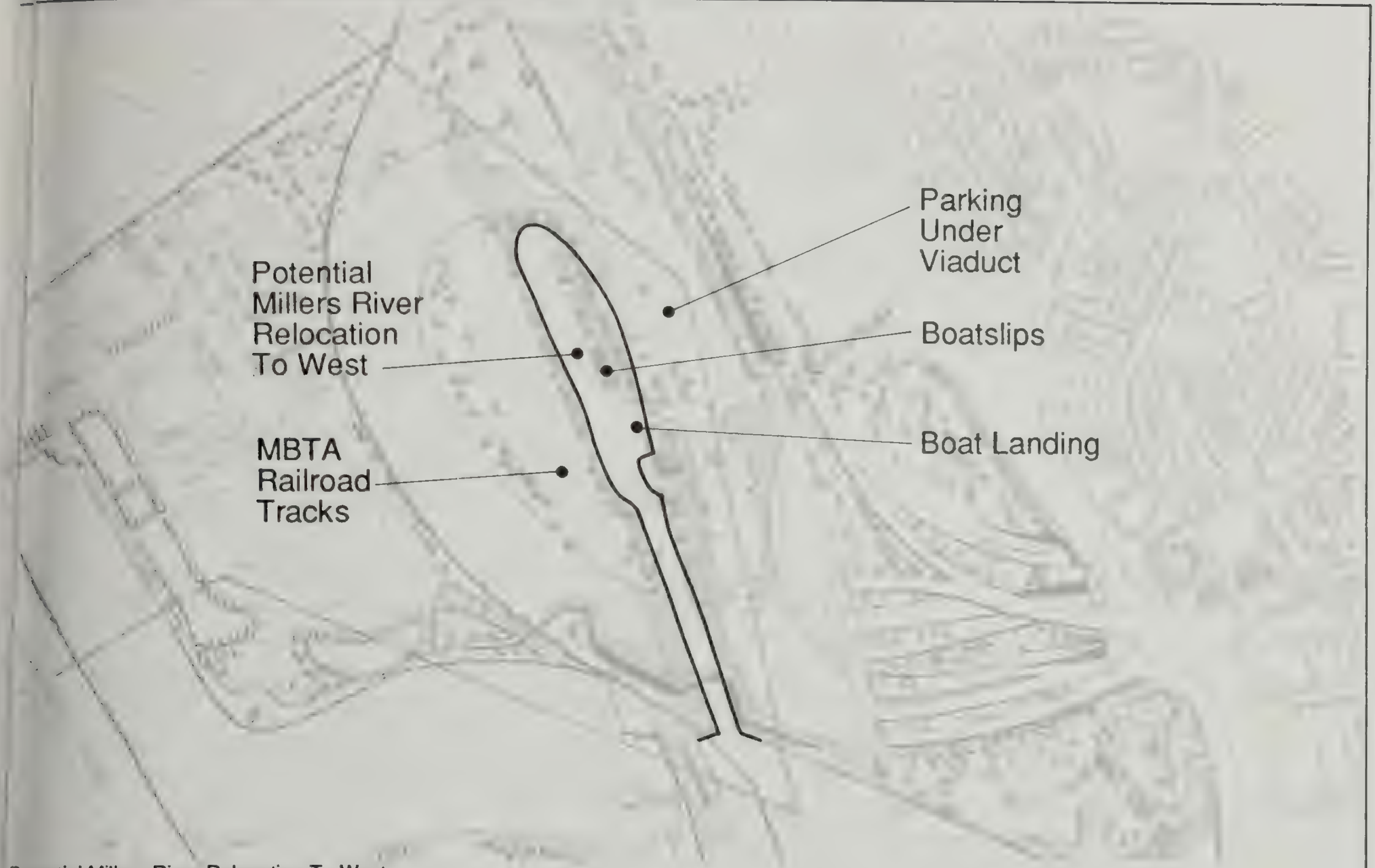

Charles River
New/Restored Pedestrian Overpass
Proposed North Point Development (Private)
New Parkland
Walkway Along River Bank And Pedestrian Bridge Over Tracks
Nashua Street
Jail
New Configuration Of Leverett Circle
Registry
Hospital
Landscaping For CANA C. 91 Conditions
Charles River
North Station
Westerly Expansion Of Revere Park
Charles River Dam
Revere Park Restoration
Walkway And Ferry Landing At Lovejoy Wharf
Improved Pedestrian Environment

FIGURE 1.29

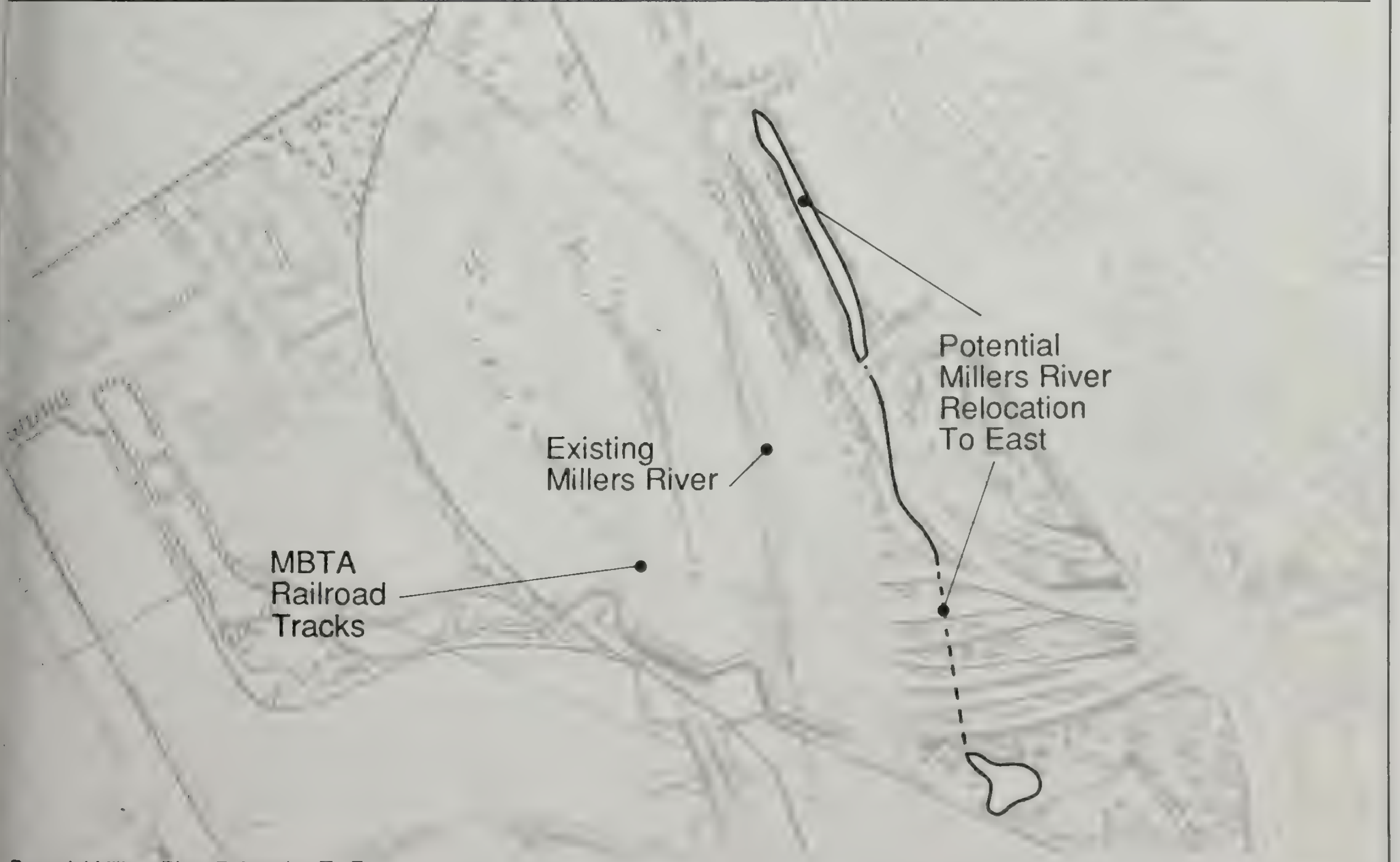
Illustrative Parkland Development Concept, Area North Of Causeway Street

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 50 100 150 200 Feet



Potential Millers River Relocation To West



Potential Millers River Relocation To East

FIGURE
1.30

Illustrative Millers River Relocation Development Concepts

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 400 800 Feet
200 600

- Lovejoy Wharf Walkway and Ferry Terminal (#4): A pedestrian walkway and a commuter ferry landing facility will be constructed on Lovejoy Wharf (see Figure 1.31).

- New Pedestrian Environment (#5): An attractive pedestrian environment will be developed on the east and north sides of the Charles River bridge transition section and abutment between Paul Revere Landing Park (south bank) and Causeway Street. Access on the west side of the bridge abutment will be determined in coordination with developers of the new Boston Garden (see Figure 1.31).

- New Portal Plaza (#6): A small urban plaza marking the entrance to Paul Revere Park would be possible in option Z Modified and would be constructed as a part of the project above the Causeway Street portal of the I-93 tunnel.

- Charles River Bridge Design (#7): Alternative Charles River bridge design features will continue to be considered, including haunched girder and cable stayed bridge structures. Bridge design is a major factor in the overall aesthetics of the area surrounding the Lower Charles River, which the FEIS/R identified as a potential measure to mitigate visual impacts on park properties. A haunched girder bridge type using a complex of four bridges on eight columns permits a more aesthetic bridge design than a standard bridge type with shorter spans and more columns. A cable-stayed bridge also has four bridges and eight supports, two of which are major towers; this bridge type is the most dramatic and potentially beautiful and creates a major gateway to the City, but is substantially more costly than other bridge types being considered.

  The major alternate bridge types would open up sight lines across and along the river at ground level and would present more aesthetically pleasing forms, which would continue to be dominant visual elements. Further engineering and aesthetic analyses will be undertaken, together with agency coordination and public discussion, in order to determine the technical and cost feasibility and desirability of alternate bridge types.

- Design and Construction of New Parkland (#8): The Department will pay for the preparation of an overall master plan, and design and contract documents for two major components of the MDC park system, and it will pay for the construction of park improvement of these properties. These are: (a) the Nashua Street parkland which provides a major opportunity for heavy public use of an extended Esplanade; and (b) the former GSA site which will be a major park node on the north bank of the river serving new development in Cambridge and connecting to Paul Revere Landing Park via the improvements in the Chapter 91 area. Land or easements along the North Point development area, which completes the connection on the north side of the river may be obtained through the development process, and the Department will provide assistance with park improvements on easements secured by the MDC. One potential action with which the Department will assist, is the possible swap of land between the GSA site and the North Point development area. This would create a continuous public waterfront through the North Point area making public parkland continuous along the north bank of the river.

- Reconfigured Leverett Circle Area (#9): Improvements to Leverett Circle will be provided, including landscaping of a larger reconfigured parkland area and reconstruction of pedestrian overpasses. Landscaping in the area will be compatible with the Charles River Esplanade ambience and will create an attractive visual terminus to Storrow Drive.

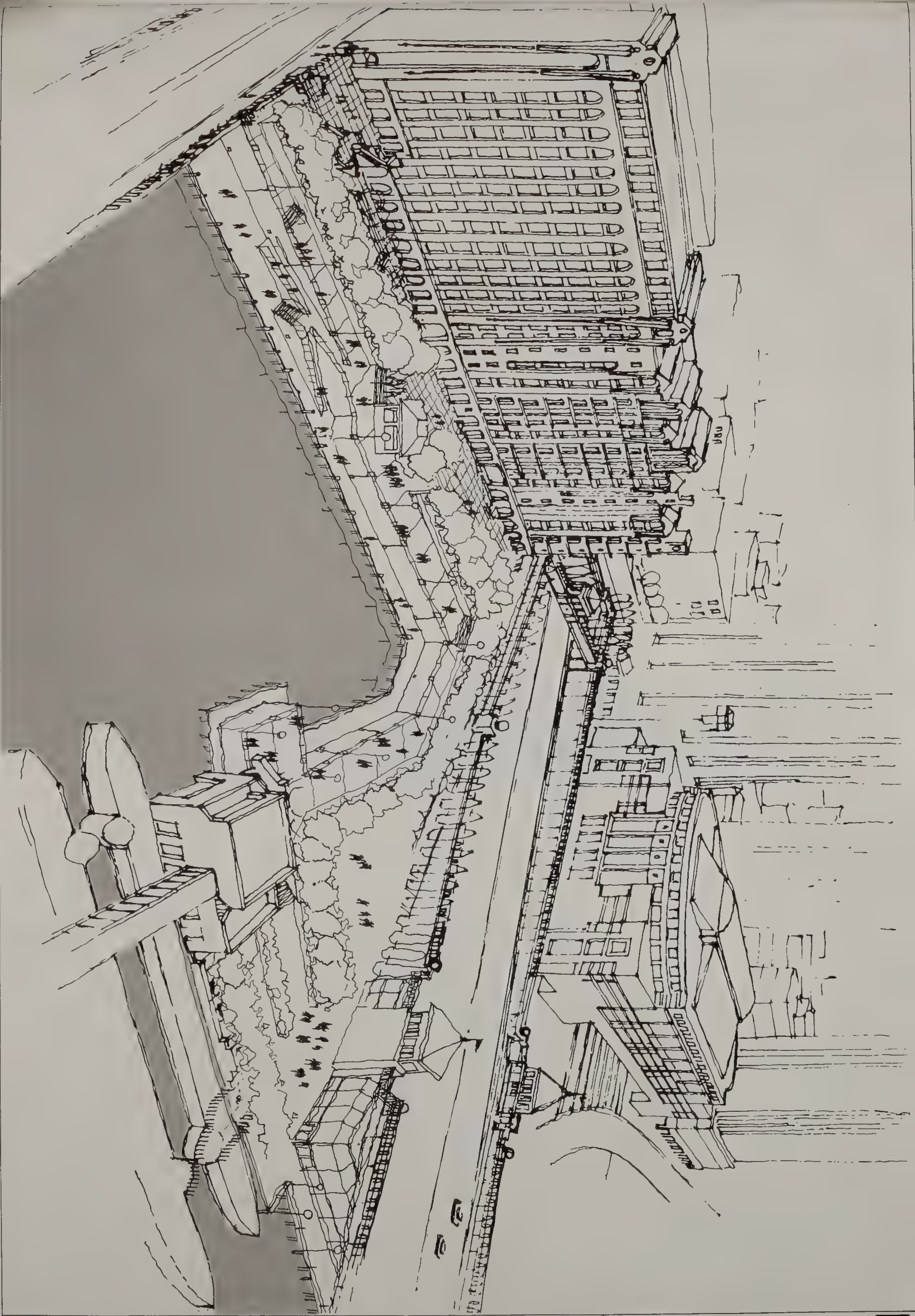


FIGURE 1.31

Illustrative Development Concept At Revere Park (South Bank) And Lovejoy Wharf

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Chapter 2 – South Boston Bypass Road

Chapter 2

SOUTH BOSTON BYPASS ROAD

This chapter presents an analysis of alternatives for the South Boston Bypass Road, an addition to the Proposed Action based on further studies and design development since the 1985 FEIS/R. Two alternatives are discussed: the South Boston Bypass Road (the Bypass Road or the Proposed Action as appropriate) and South Boston Haul Road (the Haul Road or the No-Action Alternative).

The proposed Bypass Road would be an extension of the Haul Road which is proposed as a construction mitigation measure for the Artery/Tunnel Project. The Haul Road will be located in the existing depressed railroad right-of-way between Dorchester Avenue and Congress Street. As described in greater detail below, the Bypass Road would be created by extending the Haul Road northerly to connect to the Seaport Access Highway (I-90) and southerly to connect to the Southeast Expressway (I-93).

Specifically, at its north end, the Bypass Road would connect the Haul Road to the Seaport Access Highway (I-90) and the relocated Massport Haul Road near Viaduct and Summer Streets. South of Dorchester Avenue, the Bypass Road would ascend onto a viaduct to pass over existing railroad tracks, then descend to a surface intersection at Frontage Road for connections to the Southeast Expressway (I-93).

The Bypass Road would have an intermediate entry and exit point in the vicinity of West First Street. In addition, a driveway would be provided to the MBTA Cabot Yard bus storage facility near Dorchester Avenue for use by certain MBTA vehicles.

The No-Action Alternative of maintaining the Haul Road for the indefinite future, but not connecting it to I-93 and I-90, is examined in this chapter as well.

2.1 PURPOSE OF THE BYPASS ROAD

The Bypass Road has been added to the Artery/Tunnel Project to achieve certain objectives. These objectives are to provide direct access between South Boston and regional expressways, while diverting regional traffic flows away from city streets, and to improve and maintain the overall roadway system operation and capacity of the Artery/Tunnel Project.

The Bypass Road would satisfy these project objectives by:

- reducing the number of vehicles entering the I-93/I-90 Interchange and improving levels of service of traffic operations there
- providing a limited-access right-of-way for hazardous cargo trucks to bypass tunnel portions of I-90
- relocating truck traffic from local streets in South Boston to a limited-access right-of-way

- providing a high-occupancy vehicle (HOV) route to the Third Harbor Tunnel and Logan Airport

2.2 BACKGROUND

2.2.1 Haul Road

The Haul Road is the subject of a separate Supplemental Environmental Impact Statement/Report issued prior to this SEIS/R in which alternatives and environmental impacts are discussed in detail.

The Haul Road would provide a limited-access truck route for construction vehicles generated by the Artery/Tunnel Project in South Boston and provide an alternative through truck route to relieve existing truck traffic from local streets in South Boston. It is needed because the sequence of early construction contracts will generate trucks hauling excavated material, construction materials, and equipment through South Boston. The Haul Road is intended for construction trucks generated by the Artery/Tunnel Project and other construction projects in Boston; other commercial trucks now using local streets; and empty buses travelling between the MBTA Cabot Yard and service routes. Without the Haul Road, these vehicles, including construction-generated trucks, would have to use local streets causing increased congestion and traffic safety problems in South Boston. The Haul Road is expected to effectively mitigate the effects of construction traffic generated by the Artery/Tunnel Project.

2.2.2 Bypass Road Study Schemes

After the development of the Haul Road design, and with plans for the I-90 Seaport Access Highway in place, the Department studied and considered two basic alignment schemes for connections south of Dorchester Avenue (see Figure 2.1).

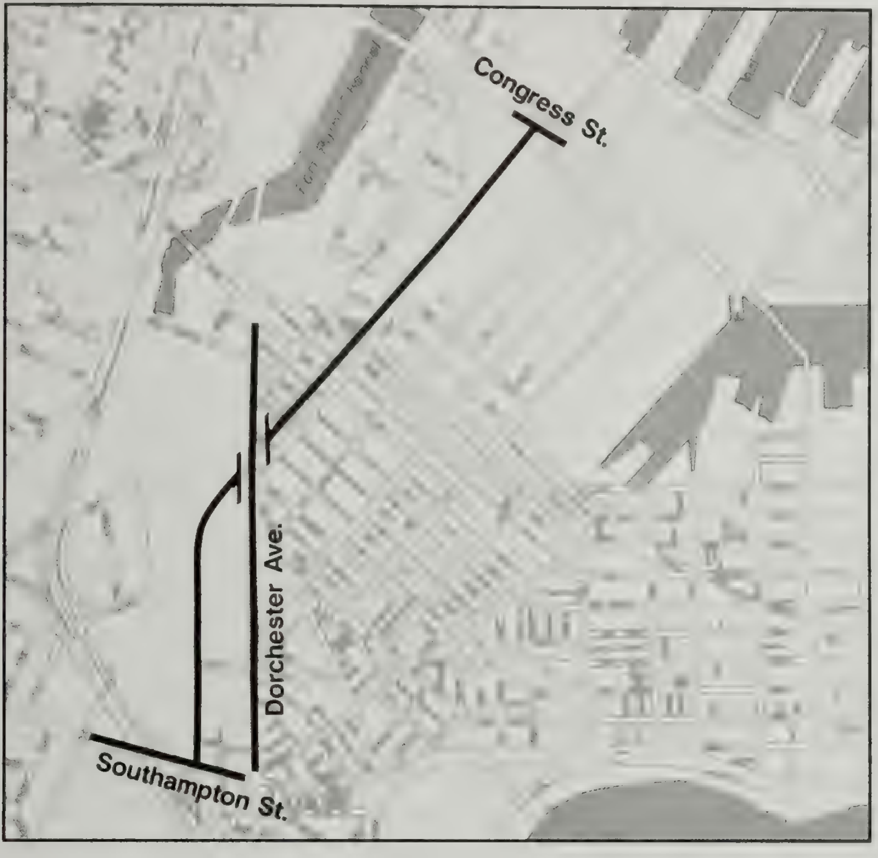
The first alignment scheme under consideration would connect with Southampton Street and its Southeast Expressway (I-93) ramps. This scheme would require crossing (at grade or on a bridge) the Consolidated Railroad Corporation's (Conrail)/Neponset Industrial freight railroad track, and must run parallel to the MBTA's Cabot Yard lead tracks to Southampton Street near the existing bridge which passes over the MBTA Red Line, and Conrail/Amtrak railroad tracks. This scheme was not carried forward for further study for several reasons:

- There is insufficient right-of-way width available for a two-lane roadway between existing buildings, railroad tracks, and the rapid transit yard lead tracks.

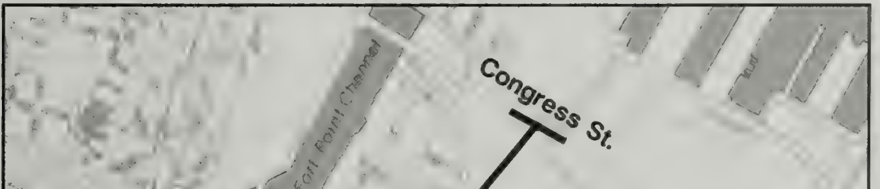
- An unsafe grade crossing and complex geometry would be required to maintain the active Conrail railroad freight track.

- Future resumption of MBTA Old Colony passenger train service would further restrict right-of-way use and increase the cost because tracks would have been added for this service.

- Dangerous 180-degree turning movements would be required from Southampton Street to reach the southbound Southeast Expressway.



Southampton Street Scheme



Frontage Road Scheme

FIGURE 2.1

South Boston Bypass Road Study Schemes

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

The other alignment scheme south of Dorchester Avenue terminates at the northbound Frontage Road with direct connections to the Southeast Expressway (I-93) both north- and southbound. Three variations of this scheme were studied to determine the best way to cross the railroad yards between the Frontage Road and Dorchester Avenue. These crossing variations were are at grade, in a tunnel, or on an elevated structure.

The at-grade surface crossing of many busy railroad tracks (some with high superelevation) was not carried forward for further study for both safety and technical feasibility reasons. The safety issue is especially acute, since hazardous cargoes are among the designated users of this roadway. The tunnel crossing was not carried forward for further study because it did not satisfy a project objective of providing seaport access from regional expressways for hazardous cargoes, which are excluded from tunnels.

The remaining crossing variation, an elevated alignment above the railroad tracks, was found to be feasible and has been advanced by the Department as the proposed South Boston Bypass Road. This alignment would utilize a viaduct structure extending from the Conrail right-of-way at Dorchester Avenue to a reconfigured Frontage Road system near the location of the existing Widett Circle Access Road. The 1,700-foot-long structure would pass over the tracks of Conrail, the future Old Colony commuter rail, the MBTA Red Line, Amtrak yard lead, the MBTA Dorchester Branch commuter rail, and railroad car storage tracks. The existing Widett Circle Access Road and a little used storage yard track would be relocated.

2.3 ALTERNATIVES CONSIDERED IN THIS ANALYSIS

This section describes the only reasonable alternatives carried forward for further study: (1) the proposed Bypass Road and (2) the No-Action Alternative, which would involve retaining the previously constructed Haul Road as a through truck route. The Haul Road analysis is presented first because its roadway surfaces would potentially serve as the foundation for the Bypass Road described thereafter.

2.3.1 Haul Road (The No-Action Alternative)

The Haul Road will be constructed to remove Artery/Tunnel Project construction tracks and other commercial vehicles from city streets in South Boston. The No-Action Alternative to the proposed Bypass Road would be to continue using the Haul Road as a State/City truck route through South Boston for the indefinite future.

Continued use of the Haul Road as a through truck route indefinitely would require some modifications (see Figure 2.2). The northern terminus at Congress Street would be detoured during the staging of construction of I-90 through the area. Even the No-Action Alternative would require some new construction including the addition of two surface ramps over the I-90 tunnel to maintain connections with the Massport Haul Road, which would be relocated in connection with the Artery/Tunnel Project.

The Haul Road would continue to be restricted to commercial trucks and empty MBTA buses. Without this alternative, these vehicles would revert to using South Boston arterial streets generating again the congestion and traffic safety problems previously alleviated by the Haul Road.

2.3.1(a) Evaluation Of The Haul Road

The following describes and briefly evaluates this No-Action Alternative in terms of the project objectives stipulated above.

Improvement Of Level Of Service At The I-93/I-90 Interchange. The Haul Road would not serve as a link in the proposed Artery/Tunnel Project Interstate Highway System, or reduce the number of vehicles entering the I-93/I-90 Interchange to improve the level of service there. Because of the nature of the truck connections at each end of the Haul Road, nonhazardous commercial trucks and buses seeking through passage between points to the south and the seaport or the airport would have no incentive to use the Haul Road to bypass the interchange.

Provision Of A Hazardous Cargo Route. Because the Haul Road is not directly connected to I-90 or I-93, it would not present an obvious alternative for trucks carrying fuel oil, gasoline, and other hazardous cargoes which will be prohibited from using the proposed I-90 tunnel into South Boston. However, after these trucks have been forced to exit from the Interstate Highways and are travelling on surface arterials into South Boston, the Haul Road could serve as a designated through route depending upon destination. The limited-access Haul Road will be in a separate, partially depressed right-of-way, away from the front doors of residences and businesses abutting city streets.

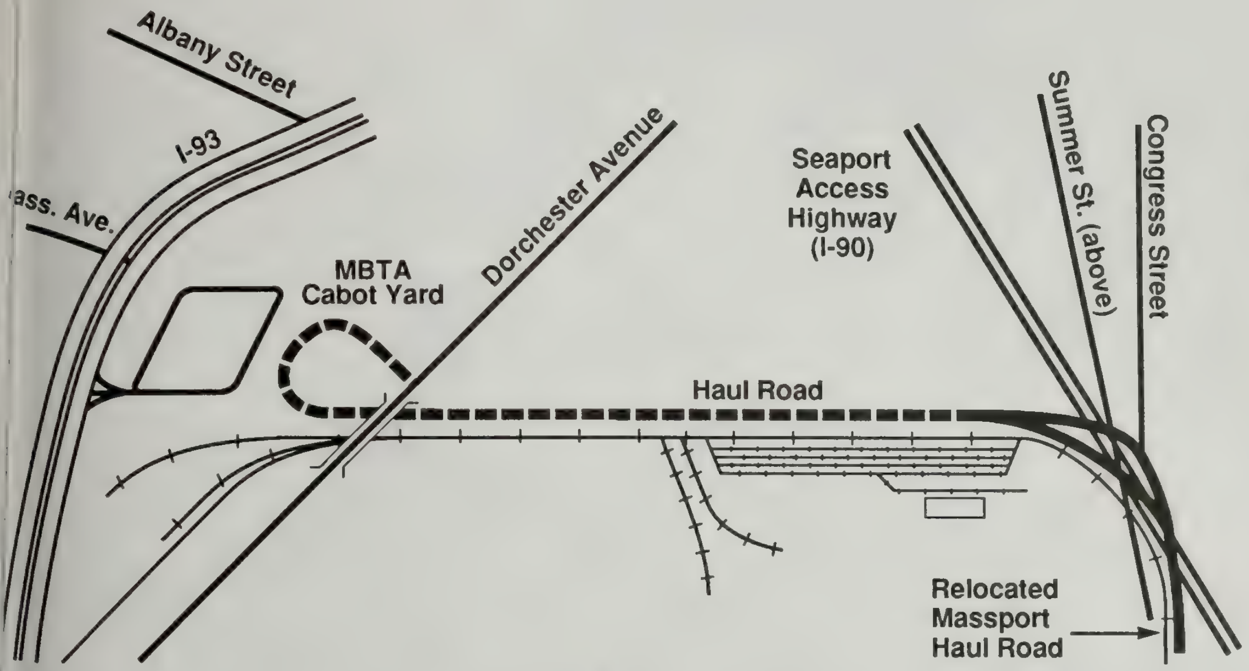
The Haul Road includes features designed to control spills and to respond to emergencies [see Section 2.3.2(a) below].

Since the Haul Road will have local connections only at its termini, at Dorchester Avenue and Congress Street, truck drivers serving the fuel oil storage on East First Street, for example, may prefer to use local streets.

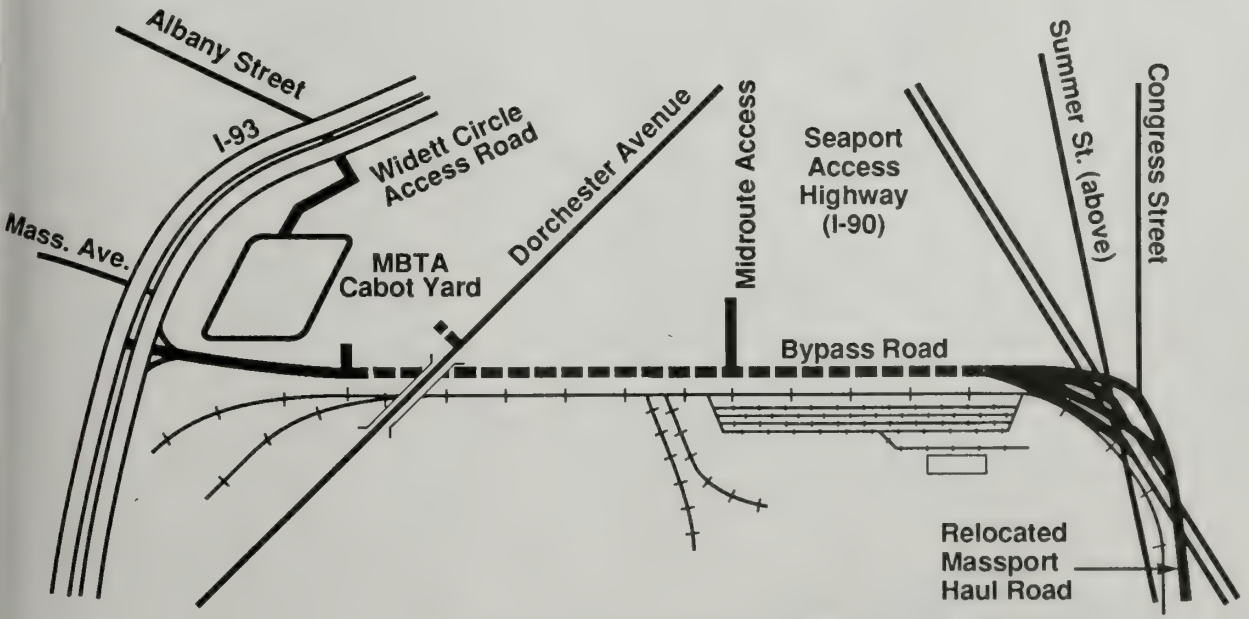
Diversion Of Truck Traffic From Local Streets. Under the No-Action Alternative, the Haul Road would become a permanent component of the local city street network. The roadway would continue indefinitely to provide an attractive limited-access alternative for passage through parts of South Boston potentially replacing a portion of the existing truck routes in South Boston (see Figure 2.3). Existing truck routes are presently located on portions of both A and C Streets which parallel the Haul Road right-of-way. The A Street truck route connects Congress Street and Dorchester Avenue, while the C Street truck route connects Fargo Street, West First Street, West Second Street and the Broadway bridge. The segment of B Street between West First and West Second Streets is being improved by the City to enhance traffic flow between the West Second Street bridge over the Conrail right-of-way and West First Street.

The Haul Road would be a connecting link between Dorchester Avenue and the relocated Massport Haul Road, relieving local streets of through truck traffic. The Haul Road, therefore, would be a compatible addition to the existing transportation system for commercial vehicles in this section of South Boston.

Provision Of An HOV Route. The Haul Road would not serve as an HOV route, because it does not have termini which are consistent with the Artery/Tunnel Project HOV strategy; it connects only to other existing truck routes. This would offer no relief in an area that is already traffic constrained by traffic flows at capacity.



South Boston Haul Road



Proposed South Boston Bypass Road

LEGEND	
▬	Constructed This Phase
▬ ▬ ▬	Earlier Phase
┼──┼	Railroad Tracks

FIGURE 2.2 South Boston Haul Road/ Bypass Road Alternatives

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

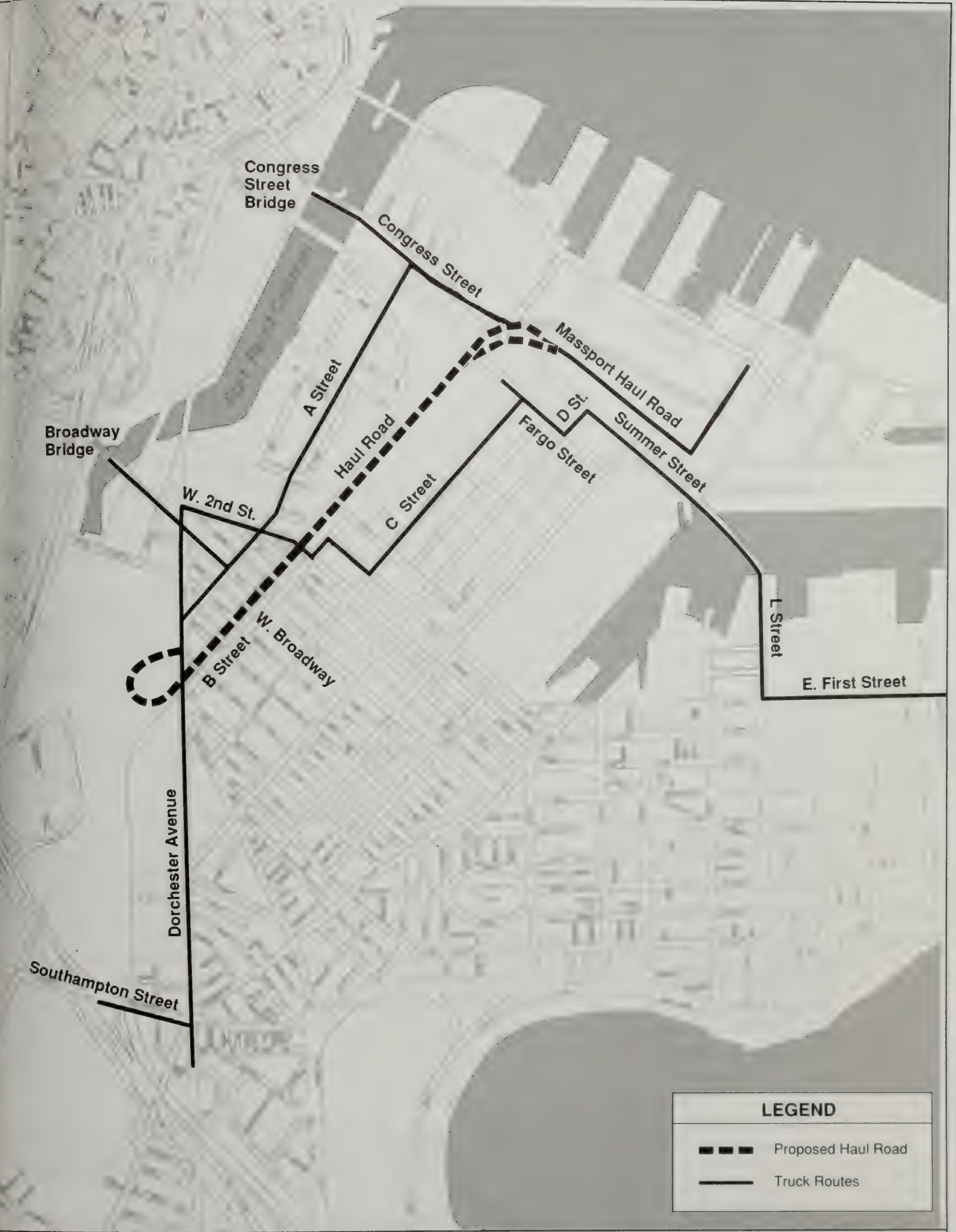


FIGURE 2.3

Location of South Boston Haul Road and Present Designated Truck Routes

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

2.3.1(b) Other Benefits Of The Haul Road

The No-Action Alternative would not provide any specific benefits to the Interstate Highway System, but would serve to continue the local benefits created by the Haul Road. The Haul Road would continue to improve the adequacy of the South Boston street system. Diversion of through tracks to the Haul Road would enable other traffic on the local streets including automobiles to move more efficiently. In addition, the Haul Road would serve both construction and economic development in the South Boston waterfront industrial area and would provide an element in a direct local route for trucks serving marine facilities and operations at the South Boston Seaport. It would also facilitate the movement of emergency vehicles.

2.3.2 Bypass Road (The Proposed Action)

The proposed Bypass Road would be an extension of and incorporate the Haul Road (see Figure 2.2). At its northern end, the Bypass Road would have ramps connecting to the Seaport Access Highway (I-90) and the relocated Massport Haul Road near Viaduct and Summer Streets. It would continue southward as a two-way surface road (one lane in each direction) along the existing Conrail railroad right-of-way, adjacent to the South Boston freight yard and continuing south in a depressed cut. It would pass beneath eight surface street bridges, including Dorchester Avenue, which would be the southern terminus of the Haul Road. From there the Bypass Road would continue on a viaduct structure passing over the existing rapid transit and railroad tracks. It would then descend to the surface to connect eventually to the Southeast Expressway (I-93) via the Frontage Road system. There would be a midway entry and exit point to A Street on the Bypass Road in the vicinity of existing West First Street. A driveway would be provided to the MBTA Cabot Yard bus storage facility near Dorchester Avenue for use by MBTA vehicles only.

The Bypass Road would provide a direct connection for those commercial vehicles and HOVs desiring access to South Boston or Logan Airport. The Bypass Road would not be open to general traffic.

Construction of the Bypass Road would require several types of structures. In the middle portion, the surface roadway would use portions of the previously built Haul Road. The main construction tasks would consist of constructing the midroute entrance in the vicinity of West First Street and probably repaving. At the north end the Bypass Road would connect with I-90 with ramps in open boat sections and tunnels and would connect with the Massport Haul Road as well as with the South Boston local street system with surface ramps to C Street. At the south end, the Bypass Road would connect with I-93 by rising onto a bridge structure that would span railroad tracks used by Conrail, Amtrak, MBTA Red Line rapid transit yard leads, MBTA Dorchester Branch commuter rail tracks, passenger car storage tracks, and the future proposed MBTA Old Colony commuter rail tracks. Seldom used storage yard tracks and the Widett Circle Access Road to the New Boston Food Market area would require relocation.

2.3.2(a) Evaluation Of The Bypass Road

The following describes and briefly evaluates the Bypass Road alternative in terms of the project objectives outlined in Section 2.1.

Improvement Of Level Of Service Of I-93/I-90 Interchange. The Bypass Road would be a connection between I-93 and I-90. Therefore, it would serve a valuable function as part of the Interstate Highway System by diverting trucks from the South Bay interchange. This would have the effect of improving the level of service of the I-90/I-93 Interchange.

Provision Of A Hazardous Cargo Route. The proposed Bypass Road would provide a nontunnel route for hazardous material vehicles that would not be allowed in the proposed tunnel sections of I-93 and I-90. The inclusion of a midpoint intersection would increase its use as a truck route for fuel trucks headed to East First Street.

The Bypass Road would improve both the safety and routing of hazardous cargo vehicle movements (especially the large number of fuel oil movements) in South Boston. Federal regulations require motor vehicles which contain hazardous materials to be operated over routes which do not go through or near heavily populated areas, places where crowds are assembled, tunnels, narrow streets, or alleys unless there is no practicable alternative. Presently, there is no practicable, well-designed surface street routing that can be used to avoid heavily populated areas altogether, but the Bypass Road is a major improvement in diverting hazardous cargoes from streets in South Boston. The hazardous cargo vehicles would be on a limited-access roadway and would not encounter the vehicle conflicts or pedestrians that they would if they were using existing streets.

The proposed Bypass Road would maintain the features designed into the Haul Road to assure that emergencies involving hazardous cargoes do not result in adverse impacts on the environment. The drainage system for the Haul Road would contain materials spilled on the road surface. The pump station that serves the drainage system would contain automatic sensing instrumentation to shut down the pumps in the event of an accidental spill. In addition the existing roadway will include fire alarm call boxes and fire hydrants to facilitate response to fire emergencies.

Diversion Of Truck Traffic From Local Streets. The traffic in South Boston now includes a large number of commercial vehicles, and construction of the Bypass Road would divert much of this commercial truck traffic away from South Boston streets. Diversion of truck traffic to the Bypass Road from the existing truck routes along Dorchester Avenue, A Street, C Street, and other South Boston streets would relieve local traffic congestion. This would enable other traffic including automobiles to move more safely and efficiently on these local streets. Diversion will be maximized by the direct connections to the Southeast Expressway (I-93) and the Seaport Access Road (I-90) and by the availability of the midpoint intersection.

Provision Of An HOV Route. The Bypass Road will provide a shorter, less congested route for HOVs traveling to and from I-93 south of Boston and Logan Airport or South Boston. This will allow HOVs to bypass the potentially congested I-93/I-90 Interchange, which would be a distinct advantage for HOV service during peak flow hours. The entrance to the Cabot Yard bus facility will allow empty MBTA buses to have better access to service routes.

2.3.2(b) Other Benefits Of The Bypass Road

The Bypass Road would improve access across South Boston for fire, police, ambulance, and other emergency vehicles. Emergency vehicles would be able to respond to calls faster due to reductions in travel time on local streets. The Bypass Road would provide an alternative travel route in the event that I-93 or I-90 became blocked temporarily due to an accident or other reason.

The Bypass Road would join into the I-93 Frontage Road system at the surface and go under elevated I-93 to give easy access to the north and south. The relocation of Widett Circle Access Road required by this connection also would improve connections to the surrounding street system for the Boston Foodmarket area.

2.4 ASSESSMENT OF IMPACTS

2.4.1 Traffic/Transportation

2.4.1(a) Traffic Volumes

A comparison of traffic volumes on selected links of the highway/street system was made for each alternative. These comparisons are shown in Table 2.1. Not all links are directly comparable, however, particularly in respect to the No-Action Alternative where capacities would be much more constrained.

For I-93, with the Artery/Tunnel Project, the link volumes for the Haul Road alternative would be always higher (by about 5 percent) than the link volumes for the Bypass Road alternative. This is because the Bypass Road alternative would have direct connections to the Southeast Expressway and could divert volumes off of I-93 in the South Station area. This would be of general benefit to I-93 traffic operations.

For the portion of I-90 between South Station and A Street (in the Fort Point Channel area), traffic volumes on the links for the Haul Road also would be generally higher (by 5 to 10 percent) than for the links for the Bypass Road. This section of I-90 is particularly critical because it will connect the I-90/I-93 interchange with the South Boston interchange and will contain a series of ramp merges and diverges. The volume reductions in this section attained by the Bypass Road option would enhance traffic operations in this area by diverting truck traffic which can utilize the alternate route afforded by the Bypass Road.

The major benefit derived from the construction of the Haul Road would be reduction of traffic from South Boston streets. This reduction would be enhanced with the Bypass Road (in the Proposed Action) because vehicles from either I-93 or I-90 can use the Bypass Road to local South Boston destinations and because the Bypass Road would provide an alternative route from I-93 to the south to I-90 to the east. Table 2.1 shows the anticipated year 2010 AM and PM peak hour volumes for selected links in this area.

For the adjacent South Boston area, the traffic volumes on the Bypass Road would be four to five times as great as the volumes on the Haul Road alternative. Again, this is due to the fact that the Bypass Road alternative would connect directly to the Southeast Expressway and provide a direct route to industrial South Boston and I-90. The much lower Haul Road alternative traffic volumes indicate that this option would serve only local needs.

For the West Fourth Street bridge, traffic volumes for the Haul Road alternative would be higher than the Bypass Road alternative. This indicates that the West Fourth Street bridge would carry additional hazardous cargo to the Haul Road.

For the area of Summer Street east of D Street, the traffic volumes for the Haul Road would be some 10 to 20 percent higher than for the Bypass Road. These volumes are very

Table 2.1

COMPARATIVE VOLUMES ON SELECTED HIGHWAY LINKS

Location		Haul Road		Bypass Road	
		AM	PM	AM	PM
I-93	NB	6,416	5,551	6,016	5,297
at West Fourth Street	SB	7,624	9,018	7,436	8,608
I-90	EB	4,316	2,791	3,916	2,537
at Fort Point Channel	WB	3,898	4,984	3,710	4,574
Haul Road					
from Dorchester Avenue	NB	15	19	N/A	N/A
to Massport Haul Road	SB	15	23	N/A	N/A
Bypass Road					
from I-93 to	NB	N/A	N/A	608	364
Interim Intersection	SB	N/A	N/A	255	627
Bypass Road					
from Interim Intersection	NB	N/A	N/A	470	311
to Massport Haul Road/I-90	SB	N/A	N/A	279	528
West Fourth Street Bridge	EB	696	607	635	540
east of I-93	WB	987	722	955	535
Summer Street	EB	705	929	477	888
east of D Street	WB	776	368	642	254

---

1. N/A: Not applicable

Source: Bechtel/Parsons Brinckerhoff

significant because with the Haul Road alternative, much more traffic would want to filter through local South Boston streets (such as L Street) than with the Bypass Road alternative which would allow vehicles from the Southeast Expressway the choice of remaining on the interstate system rather than diverting through South Boston streets.

2.4.1(b) Highway Operations

On the Bypass Road north of Dorchester Avenue, the average speed in both the AM and PM peak hours will be 40 mph in the northbound direction, and 30 mph southbound. In comparison, speeds would average 30 mph in both directions during both peak hours on the Haul Road. Traffic volumes for both the Bypass Road and Haul Road alternatives would be significantly lower than their capacities. Table 2.2 compares speeds and levels of service under the Haul Road and Bypass Road alternatives for selected highway links on I-93 near West Fourth Street, and I-90 at Fort Point Channel. The data in the table incorporate the effects of traffic weaving operations.

Operating speeds on I-93 northbound would increase by 6 mph (from 30 to 36 mph) in the AM peak hour, and 4 mph (from 34 to 38 mph) in the PM peak hour as a result of the Bypass Road. In the southbound direction, the marked difference in weaving and nonweaving speeds under the Haul Road alternative indicates unsafe, turbulent operating conditions with queues resulting from the LOS F weaving conditions. In comparison, traffic under the Bypass Road alternative would operate at a more stable, safer LOS E. On I-90, traffic operations would be similar under both the Haul Road and Bypass Road alternatives, except in the westbound direction during the PM peak hour, when the Bypass Road would cause speeds to increase by 4 mph (from 30 to 34 mph).

The major reason for the improvement in traffic weaving operations is that the Bypass Road alternative would reduce traffic volumes on these highway sections and reduce either on-ramp or off-ramp volumes in this area. Since the ramp flows are generally the major contributors to weaving difficulties, the Bypass Road alternative (which would decrease these ramp volumes) would improve traffic weaving operations on these sections.

2.4.1(c) Intersection Level Of Service

The primary surface street intersection affected by the Haul Road/Bypass Road comparison is Andrew Square in South Boston. This is already a complicated intersection of three major streets with six roadway approaches and a complex traffic signal system. Levels of service analyses were performed and are shown in Table 2.3. Level of service characteristics include the average delay (in seconds) for vehicles at approaches, a volume-to-capacity ratio for approaches and a level of service letter designation for approaches.

With the Haul Road alternative, vehicles from the Southeast Expressway (and other arterials) would tend to exit the expressway and divert to local South Boston streets and, in particular, often would pass through Andrew Square. The Bypass Road alternative would provide a direct routing attracting vehicles to stay on the Southeast Expressway and exit at the Frontage Road connection to the Bypass Road as a route to industrial South Boston and I-90. This characteristic of the Bypass Road option would significantly reduce traffic volumes on Dorchester Avenue and Preble and Southampton Streets. This can be seen by the reductions in approach delay and volume-to-capacity ratios for these approaches in Table 2.3.

Table 2.2

WEAVING ANALYSIS

Location		Haul Road Weaving Vehicles	Haul Road Nonweaving Vehicles	Bypass Road Weaving Vehicles	Bypass Road Nonweaving Vehicles
AM PEAK HOUR					
I-93 NB	LOS	E	E	E	E
Mass Ave. to I-90 EB	Speed (mph)	30	30	36	36
I-93 SB	LOS	F	D	E	E
I-90 WB to Mass. Ave.	Speed (mph)	28	46	34	34
I-90 EB	LOS	E	E	D	D
I-93 to Congress St.	Speed (mph)	40	40	41	42
I-90 WB	LOS	D	E	D	D
Congress St. to I-93	Speed (mph)	40	40	41	42
PM PEAK HOUR					
I-93 NB	LOS	E	E	E	E
Mass Ave. to I-90 EB	Speed (mph)	34	34	38	38
I-93 SB	LOS	F	D	E	E
I-90 WB to Mass. Ave.	Speed (mph)	27	44	30	30
I-90 EB	LOS	C	C	C	C
I-93 to Congress St.	Speed (mph)	45	49	46	50
I-90 WB	LOS	E	E	E	E
Congress St. to I-93	Speed (mph)	30	30	34	34

Source: Bechtel/Parsons Brinckerhoff

Table 2.3

INTERSECTION LEVEL OF SERVICE ANDREW SQUARE APPROACHES

		Approach Delay (sec/veh)		Volume-to-Capacity Ratio		Level of Service	
Location		Haul Road	Bypass Road	Haul Road	Bypass Road	Haul Road	Bypass Road
AM PEAK HOUR							
Southampton St.	SEB	51	47	0.63	0.43	E	E
Preble St.	WB	160	84	1.17	1.00	F	F
Dorchester Ave.	NB	75	71	1.01	1.00	F	F
Dorchester Ave.	SB	56	52	0.93	0.90	E	E
Boston St.	NEB	45	45	0.91	0.91	E	E
Dorchester St.	SWB	57	57	0.98	0.98	E	E
PM PEAK HOUR							
Southampton St.	SEB	48	47	0.23	0.18	E	E
Preble St.	WB	80	75	0.97	0.95	F	F
Dorchester Ave.	NB	31	30	0.68	0.67	D	D
Dorchester Ave.	SB	94	60	1.07	0.96	F	E
Boston St.	NEB	59	59	0.91	0.91	E	E
Dorchester St.	SWB	40	40	0.44	0.44	E	E

Source: Bechtel/Parsons Brinckerhoff

2.4.1(d) I-93/I-90 Ramp Connections

At the I-93/I-90 Interchange in the South Station area, the two major ramp connectors between I-93 and I-90 would be affected by the Bypass Road alternatives. These are the I-93 northbound off-ramp to I-90 eastbound and the I-90 westbound off-ramp to I-93 southbound. A level of service analysis was performed with the results shown in Table 2.4.

Under the Haul Road alternative, the traffic volumes on these two ramps would increase by a range of from 200 to 400 vehicles per hour. Under the Bypass Road alternative, these volumes would be diverted from these two ramps, providing an improvement in levels of service. In particular, there would be a dramatic improvement in level of service (from LOS F with the Haul Road alternative to D with the Bypass Road alternative) for the predominant AM peak hour flow from I-93 northbound to I-90 eastbound. During the PM peak hour, the reverse would be true wherein the predominant traffic movement from I-90 westbound to I-93 southbound would improve from LOS E with the Haul Road to LOS D with the Bypass Road. Thus, the positive effect of the Bypass Road alternative is direct and measurable in comparison to the Haul Road alternative.

2.4.1(e) Pedestrian And Bicycle Circulation

The Bypass Road would have beneficial impacts on pedestrian and bicycle circulation, as compared to the Haul Road. The vast majority of trucks and HOVs using the Bypass Road would enter and leave the facility at its endpoints -- the Southeast Expressway Frontage Road to the southwest, and the Seaport Access Road and Massport Haul Road to the northeast. In comparison, access to/from the No-Action Alternative alignment would be via Dorchester Avenue on the southwest, and Congress and B Streets on the northeast, which are South Boston arterial roadways.

The Bypass Road would result in the removal of up to about 200 trucks per peak hour from these arterials. While the relevant segments of Dorchester Avenue, Congress Street, and B Street are not used heavily by pedestrians and bicycles, the reduction in truck traffic would allow for freer movements and a more pleasant environment for walking and cycling.

The intermediate access point to/from the Bypass Road, in the vicinity of West First Street, is forecast to attract relatively small traffic volumes, and therefore would not have a significant impact on pedestrian or bicycle circulation. Moreover, this entry/exit would be located in an area with negligible pedestrian and bicycle traffic.

2.4.2 Environmental Impacts

The environmental impacts discussed below are those most relevant for comparing the alternatives in order to assist decision-making.

2.4.2(a) Air Quality Impacts

Both a microscale (localized) and mesoscale (areawide) analysis were performed to predict the relative effects of the no-action Haul Road and proposed Bypass Road alternatives. As the traffic patterns associated with these two alternatives will be primarily confined to the South Boston area, both the microscale and mesoscale analyses were targeted to this area.

Table 2.4

I-93/I-90 RAMP CONNECTIONS

Ramp Location	Haul Road AM LOS	Haul Road PM LOS	Bypass Road AM LOS	Bypass Road PM LOS
I-93 NB off-ramp to I-90 EB	F	C	D	C
I-90 WB off-ramp to I-93 SB	C	E	C	D

Source: Bechtel/Parsons Brinckerhoff

Microscale Analysis. Microscale air quality modeling was performed for each alternative for the year 2010 using the MOBILE Source Emissions Factor Model (MOBILE 4) and the CAL-3QHC Air Quality Dispersion Model to estimate CO levels in the affected area adjacent to heavily congested roadways near the proposed Bypass Road. A description of the procedures used in completing these estimates are provided in the chapter on Air Quality contained in Part I, Chapter 4 of this SEIS/R. Estimates were completed for six of the 39 locations discussed in Section 4.4.2 of that chapter. The analysis was based on estimated traffic levels during the peak 8-hour traffic period (10 AM to 6 PM). Both 1-hour and 8-hour CO values were considered. Background values of 3 ppm and 1.8 ppm, respectively, were developed in accordance with procedures established in conformance with EPA and DEP guidelines and standards.

The results of the CO microscale analysis are summarized in Table 2.5 and 2.6. Estimates of concentrations of CO for applicable midblock and intersection locations in the vicinity of each analysis site are provided. The primary result of the analysis is that predicted 2010 concentrations for all alternatives will be less than (in compliance with) the National and Massachusetts AAQS at all locations analyzed. Substantial variation (assumed to be 0.5 ppm for 8-hour levels for the purpose of this evaluation) between alternatives occur at only one of the locations analyzed -- the predicted results for the Haul Road are higher at the intersection of A Street and Broadway. In all cases, the results are well below the 1-hour and 8-hour CO standards, and the air quality difference between these alternatives, therefore, will not be significant.

Mesoscale Analysis Each alternative will result in changes in the quantities of motor vehicle-related pollutants emitted in the South Boston area. These changes in "pollutant burdens" (i.e., the tons of pollutants emitted each year) provide an indication of air quality in the region and are useful in assessing relative changes in the concentrations of CO, HC, NO_x, and ozone. CO, HC, and NO_x pollutant burdens were computed for each alternative based on the estimated vehicle miles travelled (VMT), vehicle hours travelled (VHT), average travel speed, and vehicle mix for all major roadways in the South Boston study area. Descriptions of the traffic data, assumed meteorological conditions and the EPA MOBILE 4 Mobile Source Emissions Program used to estimate pollutant emissions generally are presented in the Air Quality Chapter in Part I of this SEIS/R.

Estimated annual areawide emissions of CO, HC, and NO_2 for the year 2010 are shown in Table 2.7. The results indicate that the no-action Haul Road and the proposed Bypass Road alternatives are approximately the same.

2.4.2(b) Noise Impacts

The Haul Road would carry lower traffic volumes, including truck volumes, than the same segment of the proposed Bypass Road. This would have the effect of lower noise levels at certain sensitive receptors in South Boston, including at Flaherty Park and residences in this area. The predicted traffic volumes for both the Haul Road and the proposed Bypass Road were used to assess the relative noise impacts of the two alternatives.

Sensitive areas that could be affected by the Bypass Road alternative include the studios and residences at 249 A Street (location 23), Flaherty Park (location 34), residences on West Fifth Street near the Haul Road/Bypass Road (location 35), and Rotch Playground (location 1) on Albany Street in the South End (see Figure 2.4). Noise impacts were assessed by using the FHWA STAMINA 2 model. The results are listed in Table 2.8.

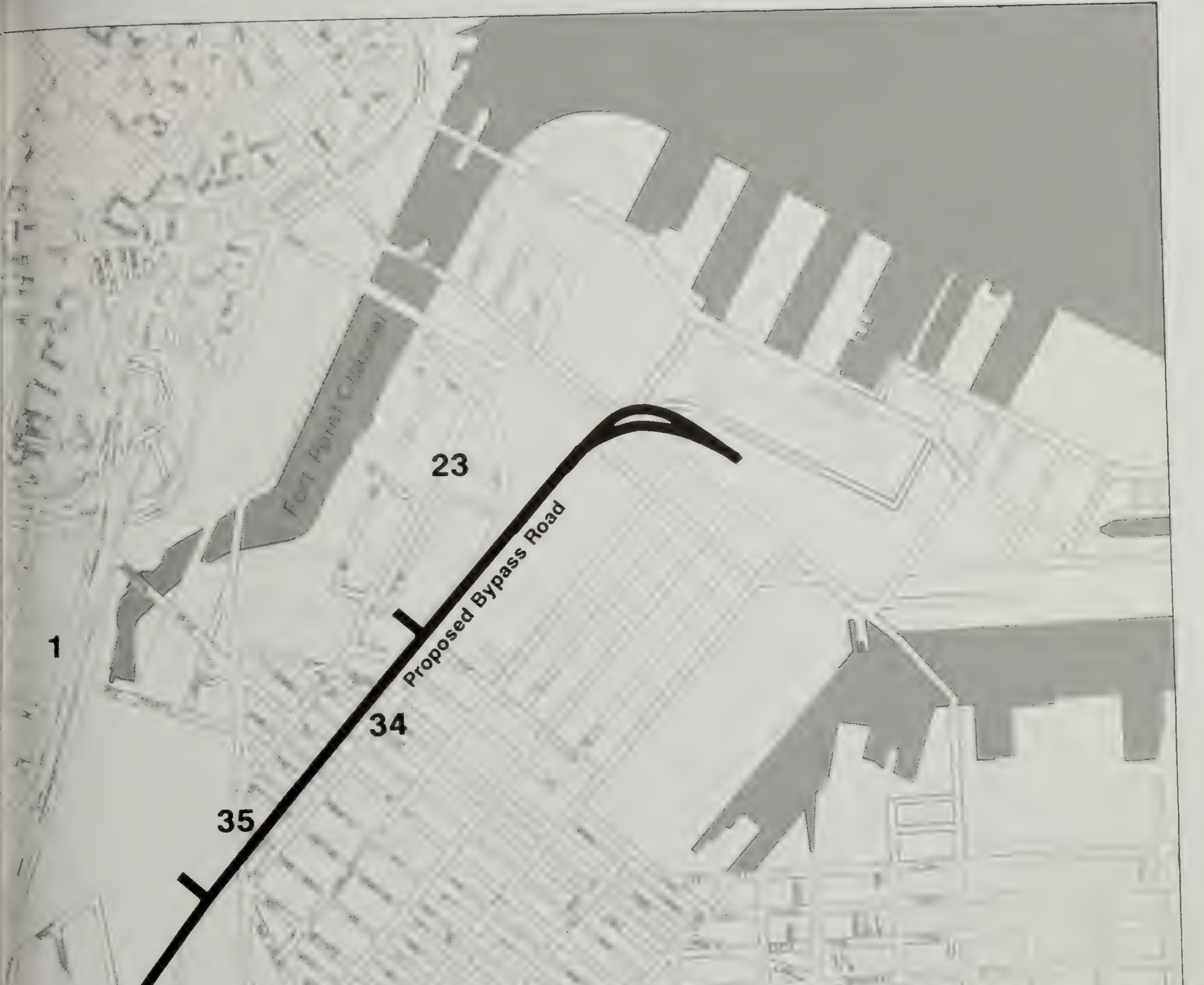


FIGURE 2.4

Location Of Sensitive Receptors For Noise

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 800 1600 2400 Feet

Table 2.5

PREDICTED WORST CASE 1-HOUR CARBON MONOXIDE LEVELS IN 2010 (ppm)[1,2,3]

		Haul Road		Bypass Road	
Analysis Site No.[4]	**Location**	**Intersection**	**Midblock**	**Intersection**	**Midblock**
20	W. Broadway/Herald & Albany	3.0	3.0	3.0	3.0
22	Old Colony & D Street	5.9	4.9	5.9	4.9
24	Northern Avenue & East Service Road	5.9	4.1	5.9	4.1
37	Fargo Street & D Street	3.7	3.9	3.7	3.9
38	A Street & Broadway (High School)	6.0	N/A	5.0	N/A
39	Third Street North of RR Tracks	3.1	N/A	3.4	N/A

---

1. One-hour standard is 35 ppm
2. All values on this table include appropriate background levels
3. 2010 CO Build Background = 3.0 ppm
4. Numbers refer to the air quality analysis sites described for the Proposed Action in Chapter 1 of the DEIS
5. N/A: Not applicable

Source: Bechtel/Parsons Brinckerhoff

Table 2.6

PREDICTED WORST CASE 8-HOUR CARBON MONOXIDE LEVELS IN 2010 (ppm)[1,2,3]

Analysis Site No.[4]	Location	Haul Road Intersection	Haul Road Midblock	Bypass Road Intersection	Bypass Road Midblock
20	W. Broadway/Herald & Albany	4.2	3.8	4.2	3.8
22	Old Colony & D Street	3.8	3.1	3.8	3.1
24	Northern Avenue & East Service Road	3.8	2.6	3.8	2.6
37	Fargo Street & D Street	2.3	2.4	2.3	2.4
38	A Street & Broadway (High School)	3.9	N/A	3.2	N/A
39	Third Street North of RR Tracks	1.9	N/A	2.1	N/A

---

1. One-hour standard is 9 ppm
2. All values on this table include appropriate background levels
3. 2010 CO Build Background = 1.8 ppm
4. Numbers refer to the air quality analysis sites described for the Proposed Action in Chapter 1 of the DEIS
5. N/A: Not applicable

Source: Bechtel/Parsons Brinckerhoff

Table 2.7

ANNUAL AIR QUALITY EMISSIONS BURDEN FOR SOUTH BOSTON IN YEAR 2010

(tons per year)

Contaminant		Permanent Haul Road	Proposed Bypass Road
CO	Highways and Ramps	1,221	1,244
	Local Streets	2,753	2,760
	Total	3,974	4,004
HC	Highways and Ramps	244	243
	Local Streets	464	465
	Total	708	708
NO_x	Highways and Ramps	236	235
	Local Streets	322	322
	Total	588	557

Source: Bechtel/Parsons Brinckerhoff

Table 2.8

PEAK HOUR NOISE LEVELS AT LOCATIONS AFFECTED BY THE SOUTH BOSTON BYPASS ROAD ALTERNATIVES

[L_{eq} (1 hour) dBA]

		Haul Road		Bypass Road		
No.	**Location**	**AM**	**PM**	**AM**	**PM**	**FHWA Criterion for Residential Areas**
1	Rotch Playground	71	68	70	67	67
23	249 A Street	73	72	72	72	67
34	Flaherty Park	64	64	71	71	67
35	31 West Fifth Street	63	63	72	73	67

Source: Bechtel/Parsons Brinckerhoff

Estimated differences in noise levels of the Haul Road alternative as compared to the Bypass Road alternative, are as follows:

- At Flaherty Park, noise levels for the Haul Road would be 7 dBA (minor impact) lower than for the Bypass Road alternative.

- At 31 West Fifth Street, next to the roadway, noise levels for the Haul Road would be 9 to 10 dBA (minor impact) lower than for the Bypass Road alternative.

- At 249 A Street, noise levels would increase by 1 dBA (not perceptible, no impact) in the AM peak hour under the Haul Road alternative, and there would be no difference in the PM peak hour.

- At Rotch Playground, noise levels would be 1 dBA higher (not perceptible, no impact) in both AM and PM peak hours under the Haul Road alternative.

Noise abatement measures will be considered for the Flaherty Park based on measurements of actual conditions. It appears, however, that these will not be necessary or recommended for the minor noise impact predicted. Abatement would involve the construction of a 12-foot-high solid barrier along the width of the park where it abuts the roadway railroad cut, and would yield only a 2- to 3-dBA noise reduction. Noise levels at 31 West Fifth Street would not exceed the FHWA noise abatement criterion of 67 dBA for land use Category B (residential) for the Haul Road, but abatement could be warranted for the proposed Bypass Road based on measurements of actual conditions. Abatement measures could consist of acoustically efficient windows. Abatement measures do not appear to be warranted at 249 A Street or the Rotch Playground based on the imperceptible increase in the predicted noise levels.

2.4.2(c) Water Quality Impacts

Both roadway alternatives would use the drainage system constructed for the Haul Road. This drainage system intercepts stormwater from surface inlets and groundwater from roadway and railroad underdrain systems, collects it at a pump station near the low point of the depressed right-of-way and discharges it to Fort Point Channel. Both alternatives would include the underdrains. The Bypass Road would intercept some additional stormwater runoff due to the increased pavement areas of the extended roadways at the north and south ends.

The daily traffic volumes predicted to travel on the proposed roadways would generate highway stormwater runoff contaminants. In general, the highway runoff pollutant loadings of the drainage discharge would be negligible. The pollutant loadings estimated to appear in the drainage discharge would be slightly higher for the proposed Bypass Road alternative than for the Haul Road alternative because of the greater traffic volumes on the Bypass Road. The highest runoff pollutant concentrations would be suspended solids and volatile suspended solids.

Permitting requirements for the Bypass Road and the Haul Road are the same -- permits for the stormwater drainage details may be required. These permitting requirements will depend upon the final design of the the drainage system, but it is expected that both alternatives would use the Haul Road's drainage system in the depressed right-of-way. The remaining portions of each road alternative would drain into other road drainage systems. For the

Bypass Road these systems would be I-93 to the south, and to I-90 and surface road systems to the north; for the Haul Road drainage to the north would be to existing surface road systems.

2.4.3 Other Impacts

2.4.3(a) Land Use Impacts

Existing Conditions. The Bypass Road would follow an existing railroad which runs through a mixed residential neighborhood/commercial district in its center section and an area of industrial development and large vacant parcels at its northern end. The southern terminus of the road would be in the Newmarket area, an industrial area owned by the Economic Development and Industrial Corporation of Boston. A recently completed revitalization plan for the Newmarket area seeks to create an attractive light manufacturing district buffered from adjacent residential districts by landscaping and transitional zones.

Impacts.

Bypass Road: The industrial areas in northern South Boston would benefit from improved access to and from the south, via the Bypass Road. The residential areas to the south would benefit from the reduction of truck traffic on local streets, a major source of conflict. At the southern end of the road, access to Widett Circle from the north would be improved as a result of the proposed relocated access road.

Haul Road: The industrial activities in northern South Boston would benefit from improved access across South Boston via the Haul Road. The residential areas of South Boston would benefit from the reduction of truck traffic on local streets. However, this road would result in less of a benefit in both aspects than would the Bypass Road, as trucks would not have direct connection to the Third Harbor Tunnel.

2.4.3(b) Relocation Impacts

Bypass Road: The proposed Bypass Road would require construction of a 1,700-foot-long viaduct structure extending from the Conrail cut area south of Dorchester Avenue adjacent to the MBTA Cabot Yard to the northbound Frontage Road in the vicinity of the existing Widett Circle Access Road and a little used yard storage track. No existing or planned railroad facilities under the proposed viaduct would be required to be relocated. The existing Widett Circle Access Road would be relocated, however, to a portion of paved property at the north end of Widett Circle, presently owned by Frontage Road Development Corporation and leased to the City of Boston for the storage of towed vehicles, providing direct access to Albany Street. A portion of the vehicle storage area would be affected by the construction of this new Widett Circle Access Road but would not require the relocation of the business now operating on the site. The proposed Bypass Road would not require the relocation of the business now operating on the site. The proposed Bypass Road would not require the relocation of any businesses in this area.

Haul Road: This alternative would require that the Dorchester Avenue entrance to the MBTA Cabot Yard become a permanent ingress and egress point for the Haul Road. This alternative would not require any new business relocations, but would require that the changes made to accommodate the Haul Road through Cabot Yard become permanent for the indefinite future.

2.4.3(c) Visual Impacts

Existing Conditions. The Bypass Road would include the Haul Road which is in a railroad right-of-way, some of which is spatially defined by both a grade separation of about 22 feet below street level and the rhythmic procession of a mix of eight stone, steel, and wooden bridges which span the depressed right-of-way between Dorchester Avenue and Bolton Streets. Much of the west side of the depressed right-of-way is defined by strong granite walls. The remainder of the west side, and all of the east side, is a mix of concrete retaining wall, eroding unretained earth banks, and glassy slopes. The bridges provide pedestrian and vehicular links across the depressed right-of-way. Views from the Bypass Road right-of-way near the Southeast Expressway would be of the South End and the Cabot Yard rapid transit and bus facilities. Views from the Bypass Road in the railroad cut are of the procession of bridges overhead the adjacent railroad track, and the surrounding walls and slopes.

At the northern end of the right-of-way, as the road passes through undeveloped areas, are distant views of downtown Boston to the west and a more immediate view of the Summer Street bridge, which acts as the northern terminus. At the southern end, the proposed Bypass Road would traverse large railroad yards owned and/or used by the MBTA, Conrail, Amtrak, Old Colony, and others.

Impacts.

Bypass Road: The construction of the Bypass Road in the depressed right-of-way would maintain the significant visual improvements to the cut itself, as well as to the surrounding neighborhood made previously by the Haul Road. The neighborhood improvements would result from the removal of truck traffic from local streets. Views of the Bypass Road occur on the eight bridges crossing over the cut. The improvements resulting from Haul Road construction would include lighting, fencing, a completely new surface for the track and road, and landscaping for erosion control.

At the southern end of the Bypass Road, the high viaduct connecting the Bypass Road to the Frontage Road near Massachusetts Avenue would appear in views to downtown from the Southeast Expressway and would become a prominent feature in a cityscape dominated by transportation and industrial uses.

Haul Road: The visual impacts of the Haul Road would be the same as those of the Bypass Road in the center section. There would be no change in the area south of Dorchester Avenue.

2.4.3(d) Economic Impacts

Impacts of the Haul Road and the Bypass Road would be both local and regional. Accordingly, both alternatives would have local and regional traffic service and economic impacts. These impacts would be positive: reduced congestion in South Boston due to diversion of trucks to an exclusive right-of-way, which in turn would decrease person hours of travel and increase time savings. These increased savings in travel time reflect the improved accessibility that would result for vehicles travelling to destinations in South Boston and to Logan Airport.

There should be no loss of tenants, sales, or lifestyle amenities as a result of construction of either alternative. On the contrary, removal of truck traffic from local streets should increase property values and the perceived amenity of residing on certain

South Boston streets. The likely impact is an increased demand for housing and slightly increased local sales due to improved accessibility for pedestrians and shoppers arriving by car. There may be some shifts in the location of the most favorable shopping or business sites due to changing traffic patterns, but the net aggregate effect on sales should be positive.

Long-term economic effects in South Boston would be positive because of improved accessibility to business and industrial (including regional seaport) facilities afforded by either alternative. The Bypass Road would have superior benefits because of direct connections to the I-93 Frontage Road and Massachusetts Avenue as well as to the Third Harbor Tunnel and the Massport Haul Road. These connections would provide substantial accessibility benefits to the seaport, local businesses, the Newmarket area, and Logan Airport.

2.5 SELECTION OF PROPOSED ACTION

2.5.1 Summary Comparison Of Alternatives

The proposed Bypass Road alternative would successfully reduce the number of vehicles entering the I-93/I-90 Interchange, as compared to the no-action Haul Road alternative. The Bypass Road would alleviate interchange ramp congestion, enhance mainline traffic operations, improve estimated speeds, and provide a direct bypass link for priority vehicles in the highway system in the event of obstructions at the interchange.

Trucks carrying hazardous cargoes which otherwise would have to exit the Interstate System onto South Boston streets could directly bypass residential and commercial neighborhoods on the limited-access roadway, and could travel part way or all the way across South Boston to various industrial destinations. General commercial truck traffic seeking through passage would be attracted to the Bypass Road also, reducing traffic congestion in South Boston. The Haul Road would offer some of these traffic benefits, but to a lesser degree.

Only the proposed Bypass Road would offer a shorter, less congested route for HOVs servicing the airport and seaport from I-93 south of Boston. The Haul Road would not support the project HOV strategy.

In general, the proposed Bypass Road would promote efficient use of both the Artery/Tunnel Project highway network and the South Boston street system. This improved level of service would result in increased safety and shorter response times for emergency vehicles when incidents do occur.

There are only marginal differences in the predicted environmental impacts of the no-action and Proposed Action alternatives. The future local air quality would be in compliance with applicable standards for both alternatives, with no significant difference between them. On a regional basis, both alternatives have approximately the same air quality impact. Noise impacts due to each alternative are predicted to be minor. Abatement measures based on measured actual conditions for adjacent residences are suggested for the proposed Bypass Road. Water quality impacts would be substantially the same for both alternatives, requiring identical permits or permit renewals for underdrains and stormwater runoff.

The proposed Bypass Road would offer generally superior opportunities in other aspects. In land use, industrial areas would benefit from direct access to interstate highways while residential areas would benefit from the reduction of truck traffic on South Boston streets. Similar and related effects are predicted for the local economy. Neither alternative would require relocations of any businesses in this area, but the Haul Road would require a permanent right-of-way across the MBTA Cabot Yard bus garage parking lot. The visual impacts of both alternatives would be the same in the northern and central sections of the right-of-way, but the Bypass Road would introduce a viaduct as a prominent feature at the south end adjacent to the Boston Foodmarket (Newmarket) area.

In summary, the environmental and urban design aspects of the alternatives would not be substantively different, while the operational advantages of the Bypass Road would be clearly superior to the Haul Road.

2.5.2 Selection Of Preferred Alternative

Based on the above assessment, the Bypass Road is the recommended alternative and has been included as part of the Proposed Action for the Artery/Tunnel Project.

Chapter 3 – Toll Plaza Locations

Chapter 3

TOLL PLAZA LOCATIONS

This chapter addresses two alternative locations and configurations for the toll plaza of the Third Harbor Tunnel (I-90): a South Boston location as shown in the FEIS/R (the Preferred Alternative) and a Logan Airport alternative as described in Part I of the SEIS/R (the Proposed Action). These alternatives differ in their effectiveness in meeting the overall project objectives of improving east-west cross-harbor traffic flows, as well as overall roadway systems operation, by means of special roadways for high-occupancy vehicles (HOVs).

Design of the project has advanced well beyond the level of the FEIS/R, permitting more detailed evaluation. Both alternatives have been developed beyond the 1" = 100' level in plans with profile and sections, and both also have been studied at 1"=40'. Preliminary design level evaluations of the South Boston toll plaza, described below, led the Federal Highway Administration (FHWA) and the Massachusetts Department of Public Works (the Department) to consider the Logan Airport alternative for both operational and environmental reasons. All categories of environmental impact were considered during this process. Some environmental issues such as air quality and noise were first considered qualitatively; subsequent quantitative analyses are presented in this chapter. These analyses support the decision to locate the toll plaza at Logan Airport.

3.1 DEVELOPMENT OF ALTERNATIVES

3.1.1 Design Objectives

The development of alternative toll plaza locations since the FEIS/R and the evaluation of those alternatives are based on the design objectives outlined below. Further development of the project design, updated traffic projections, and new traffic management methods heighten the significance of these objectives as they were defined earlier.

3.1.1(a) Geometrics
Toll plazas on any highway cause vehicles to approach other vehicles which have stopped. Thus, safety at toll plazas is affected by factors such as visibility, signage distances, signage, whether the approach is level or up- or downhill, curved or straight, and the volume of traffic and length of queues at a particular time. Changes in lighting and pavement conditions at a tunnel portal compound these factors. Optimizing safety is an obvious consideration in selecting a design. The shift in alignment that led to Alternative 5A Modified (the Preferred Alternative in the FEIS/R) permitted the location of the toll plaza on Commonwealth Flats in South Boston. The right-of-way constraints, however, required the presence of vertical and horizontal curves in the approach to the toll booths and limited the distance available beyond the toll booths for traffic to separate into mainline and HOV lanes and to reach local off-ramps.

3.1.1(b) Traffic Management
The design of toll plazas can affect traffic flow on the highway system; traffic management and facilitation of HOV access also play significant roles.

During preliminary design, it was recognized that traffic management was a key aspect of project design, particularly at the Third Harbor Tunnel. Such controls involve the spacing or "metering" of traffic entering the tunnel at either end in response to continuous monitoring of traffic conditions throughout the system and computerized analysis of the optimum rate for vehicles to pass control points. It also includes quick response to incidents such as breakdowns and accidents in the tunnel. Traffic management can have benefits for traffic flow equivalent to adding more lanes, since a substantially higher volume can be carried by each lane if unstable (stop-and-go) conditions are avoided. Because the Third Harbor Tunnel is constrained to two lanes in each direction, it is a critical location for traffic management. This was a consideration in the value engineering and environmental evaluations of the toll plaza alternatives.

3.1.1(c) HOV Operations

The Third Harbor Tunnel is the key link in a regional HOV system because of its location between Logan Airport, and the Massachusetts Turnpike, the Central Artery, the Southeast Expressway, and the South Station Transportation Center. A successful HOV system is crucial to achieving the greatest improvements in regional highway operations. These considerations were among those that prompted the FHWA request in April 1989 for a more extensive HOV system and an analysis to address the operation of such HOV lanes.

Studies of ground access to Logan Airport have shown that HOVs are a critical component in a program to reduce vehicular impacts (Massachusetts Port Authority, Logan Airport Ground Access Study, April 1987). This is because rapid transit and water shuttle service, while important components in a strategy to reduce vehicle trips to the airport, can serve only a small portion of the airport's regional service area. The most promising alternatives to private automobile access are express buses, limousines, and remote parking facilities with shuttle bus connections to the airport. The overall success of the airport vehicle reduction program depends on the effectiveness of the HOV system serving Logan. The Third Harbor Tunnel is a constrained link in this system, in which HOVs would use the same lane as general traffic. Preferential entry for HOVs into the tunnel is therefore critical. These considerations are key factors in the choice of the toll plaza location.

3.1.2 Background

The toll plaza for the Third Harbor Tunnel is an integral part of the Artery/Tunnel Project, and has been a key project element since the Draft EIS (DEIS) stage. Toll collection on the Third Harbor Tunnel, which is an extension of I-90 (the Massachusetts Turnpike), is necessary for project financing.

The DEIS examined alternative tunnel alignments, each with a two-way toll plaza located in East Boston. A design modification (5A Modified) was also proposed, shifting the tunnel alignment further to the east. This shift in alignment moved the tunnel out of Jeffries Cove onto Bird Island Flats and its ventilation building farther from the Jeffries Point neighborhood. It also resulted in the relocation of the toll plaza to Commonwealth Flats in South Boston. In doing so, it was presumed that the toll plaza relocation would improve air and noise in the East Boston community without worsening these impacts in South Boston residential areas, and without reducing the effectiveness of the design. Simultaneously with the environmental process, a system of one-way tolls was tested and then permanently adopted on the Sumner Tunnel and Tobin Bridge. Tolls on the Third Harbor Tunnel should accordingly be collected in the inbound (westbound) direction to be consistent with this regional toll collection policy.

A toll plaza in the vicinity of the 1-93/I-90 Interchange was investigated in the FEIS/R and found not to be feasible because of limitations in geometric conditions.

The FEIS/R presented Alternative 5A Modified as the Preferred Alternative. Since the FEIS/R, the Preferred Alternative has undergone development in all parts of the project. Aspects relevant to the toll plaza alternatives are:

- The project now includes a more extensive system of ramps and exclusive lanes designed to give priority to HOVs. These HOV improvements are important to improved traffic operations over the long term and to strategies designed to control environmental impacts through the encouragement of the use of HOVs.

- The airport interchange has been redesigned to reduce impacts on East Boston Memorial Stadium Park, and to move the interchange further from the residential community. This change also makes possible an airport toll plaza relatively far from residential areas.

- Traffic management technologies have been improved. It is now clear that traffic entering the Third Harbor Tunnel will require metering at both ends: traffic will be controlled by signals and enforcement personnel so that it enters at a rate that optimizes traffic flow through the tunnel.

The South Boston toll plaza received further engineering study both in terms of value engineering, which examined potential modifications both to improve the cost-benefit ratio, and in terms of its role in a projectwide HOV system. The Logan Airport toll plaza was developed during this period as a possible alternative to improve the safety and performance of the HOV system; subsequently, it was subjected to a value engineering review. The two toll plaza alternatives have been analyzed in terms of safety, traffic flow, toll plaza operations, and environmental impacts, as well as HOV system performance.

3.2 DESCRIPTION OF ALTERNATIVES

Two alternatives are presented here:

- a South Boston toll plaza based on the FEIS/R Preferred Alternative
- a Logan Airport toll plaza, the Proposed Action

Both alternatives are the result of FHWA review of the Artery/Tunnel Project's HOV system, the Department's response to FHWA comments, and value engineering review.

3.2.1 Design Constraints

The Third Harbor Tunnel toll plaza will be a part of the regional system of highways crossing Boston Harbor, all of which are toll highways; the other cross-harbor links are the Sumner and Callahan Tunnels and the Tobin Bridge. In 1984, one-way toll collection was instituted on these highway links, and subsequent studies have confirmed that one-way collection improves systemwide traffic flow and reduces environmental impacts. Tolls must be collected on the inbound side of *all* links; otherwise it would be possible to avoid tolls by using the toll-free side of one highway inbound and the toll-free side of another highway outbound.

The Third Harbor Tunnel is a constrained segment in the regional highway system because it is limited to two travel lanes in each direction. Metering of traffic is an important method of improving traffic flow in a constrained situation.

In South Boston, the toll plaza would be located between the portal of the Third Harbor Tunnel and the South Boston interchange between the Seaport Access Road, the South Boston Bypass Road, and local street connections. The alignment also would have to minimize land use and economic impacts on the waterfront industrial area and local streets.

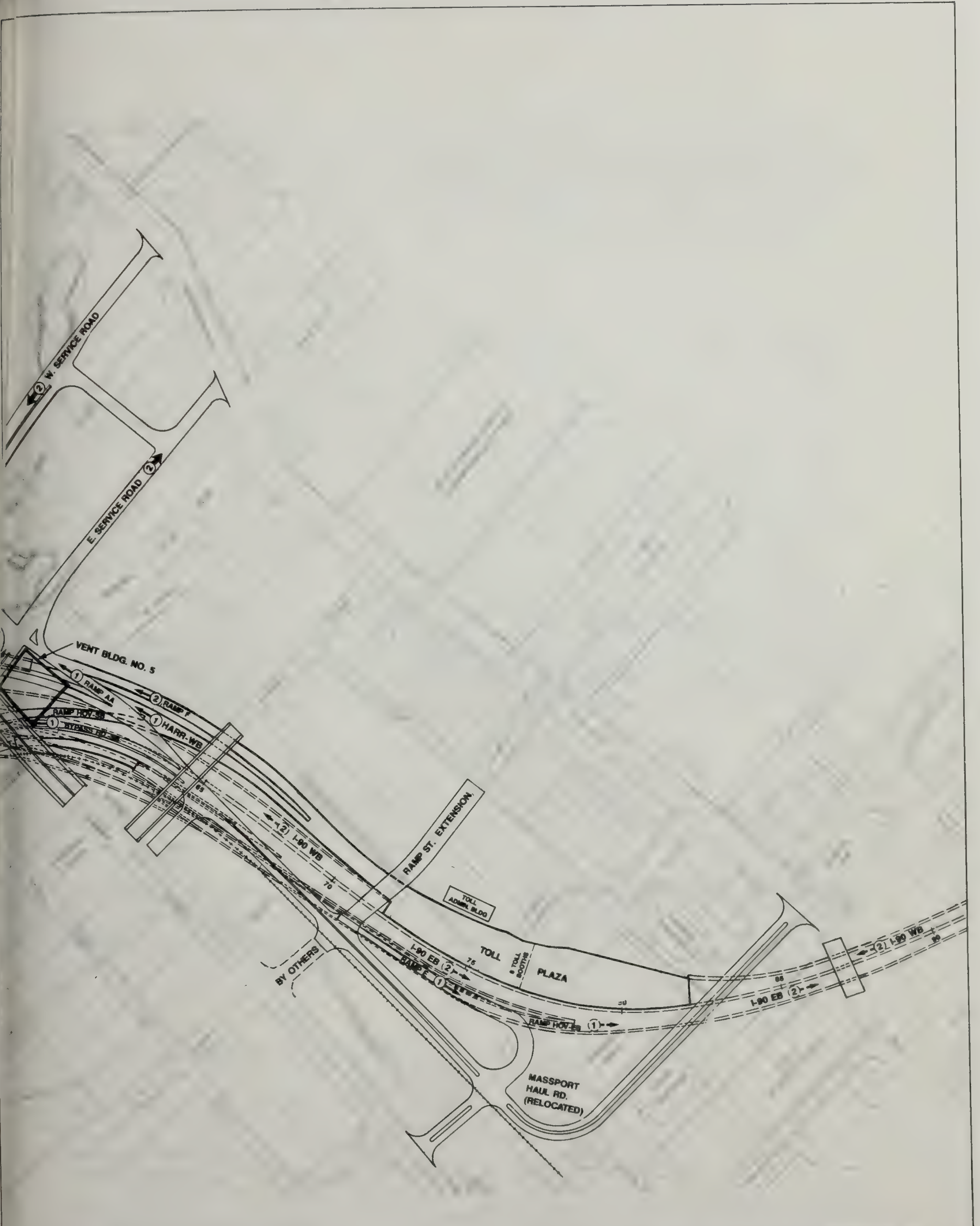
At Logan Airport, the toll plaza will be located between Bird Island Flats and East Boston Memorial Stadium Park, while allowing for adequate geometric connections to the airport roadway interchange and the mainline connection to Route 1A. It must minimize land use and economic impacts on the Logan South development area on Bird Island Flats and the airline terminals.

3.2.2 South Boston Toll Plaza

As shown in Figure 3.1, the toll plaza would be located on the westbound side of the I-90 mainline between Northern Avenue and Summer Street on Commonwealth Flats. The toll plaza would be in a 1,000-foot depressed open section between the Third Harbor Tunnel and a tunnel under local South Boston roadways. The two westbound travel lanes would separate into eight toll collection lanes, which would then merge into two covered mainline travel lanes headed for the South Bay interchange, a two-lane local exit ramp to Congress Street, and a one-lane ramp which would divide into ramps leading to the South Boston bypass HOV lane and the ramp connection to the South Station Transportation Center. A toll administration building is to be located at the north edge of the toll plaza area. The two eastbound lanes of I-90 would remain in a tunnel section adjacent to the toll plaza; an eastbound HOV ramp would merge with the mainline lanes of traffic in this area.

Since the FEIS/R, the design in this area was further developed to include eastbound HOV lanes to the tunnel portal, as well as in the opposite direction, westbound HOV connections to the South Bay area and South Boston Bypass Road (see Chapter 2 of Part II of the SEIS/R). The alignment of the Third Harbor Tunnel was shifted approximately 400 feet to the east; this shift in alignment reduced the curvature of the roadways in the toll plaza area, improving sight lines.

At Logan Airport, two lanes of airport terminal area traffic would merge with airport service traffic in a depressed open roadway, and then with two lanes of Route 1A southbound traffic in a tunnel. All traffic would merge into two lanes in the Logan South area and enter the Third Harbor Tunnel. In the opposite direction, eastbound traffic emerging from the tunnel would separate into roadways that parallel the westbound components described above. Terminal area traffic roadways and a future HOV lane would provide access to the Central Airline Terminal to the north. An emergency response vehicle garage and traffic enforcement center would be located near the tunnel entrance.



FIGURE

3.1 **South Boston Toll Plaza**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

3.2.2(a) HOV System

Eastbound HOVs would use an exclusive lane on the Seaport Access Road, merging briefly with HOVs and commercial vehicles from the South Boston Bypass Road. HOVs would bypass the South Boston interchange and receive head-of-the-line privileges at the entrance merge to the Third Harbor Tunnel. Westbound HOVs from Logan would receive priority in entering the tunnel.

3.2.3 Logan Airport Toll Plazas

As shown in Figure 3.2, this alternative would have a split toll plaza at Logan Airport. As in the South Boston alternative, toll collection could occur only in the south- or westbound direction. There would be separate plazas for airport traffic (north of the Eastern Airlines Reservation Center) and Route 1A traffic (on the site of the Eastern Airlines cargo building), each approximately 1,000 feet by 150 feet. The sequence of merges would be the same as for the South Boston alternative, except that airport terminal and service traffic would merge at the toll plaza. The merge of airport and Route 1A traffic would occur downstream of both plazas. A toll administration building, emergency response vehicle garage, and traffic enforcement center would be low buildings with ground floors at the depressed toll plaza level. A connecting bridge would provide a secure link between the two parts of the toll plaza.

In South Boston, the absence of toll booths would permit better spacing of connections to accommodate westbound traffic separating into mainline and local access streams. The absence of toll booths also would make it possible to provide a wide cross section for the eastbound traffic metering area. A tunnel administration building and operations control center would be located north of the open boat section near the tunnel portal in South Boston.

3.2.3(a) HOV System

The Logan Airport alternative would have the same provisions for HOVs as the South Boston alternative, except that westbound HOVs would have an exclusive lane permitting them to bypass other traffic entering the Third Harbor Tunnel.

On the South Boston side, the eastbound merge of HOVs with general traffic entering the tunnel would be improved by a widened merge and traffic metering area. This would be possible because the right-of-way needed for westbound toll plaza lanes in the other alternative could be made available to the eastbound side of the roadway in this alternative.

3.3 ALTERNATIVES ANALYSIS

3.3.1 Traffic And Transportation

3.3.1(a) Geometrics

The alternatives differ in geometrics, primarily in the westbound direction.

The South Boston toll plaza would be located on horizontal and vertical curves due to right-of-way and geometric constraints; this configuration would shorten sight lines, leading to both safety and operational concerns. These concerns include longer queues in the inside of the curve (right-hand lanes), similar to the situation on the existing approach to the Sumner Tunnel toll plaza.

Unequal queuing in the toll plaza approach lanes would reduce the capacity of the toll plaza to process waiting vehicles, and there is an increased risk of rear-end collisions in the right-hand lanes. Visibility problems due to the curved alignment would be compounded in daytime hours by the transition from the light levels of the tunnel to the open toll plaza, from dry pavement to wet or icy pavement in some weather conditions, and by direct glare during the afternoon peak period in winter months.

Merge and weave movements from the toll booths to the Seaport Access Tunnel and ramps would occur on a curve over a distance of approximately 800 feet upstream of the toll booths and 400 feet downstream to the portal of the Seaport Access Road tunnel. These distances are inadequate for the movements to occur smoothly and safely. The toll plaza also would make it difficult to provide appropriate signage for these movements.

Under the Logan Airport alternative, cars emerging from the tunnel would not encounter queues at the tunnel portal, improving safety. The elimination of toll booths from South Boston would provide acceptable distances for merges and weaves between the tunnel and the South Boston interchange. In East Boston, traffic headed for the tunnel would approach a queue at the toll plaza, but the geometry of this approach would be straight and level for through traffic moving at highway speeds, providing good visibility of stopped traffic ahead. Traffic approaching the toll plaza from the airport terminals would be on a curve, but moving at slower speeds than through traffic from Route 1A.

3.3.1(b) Signs

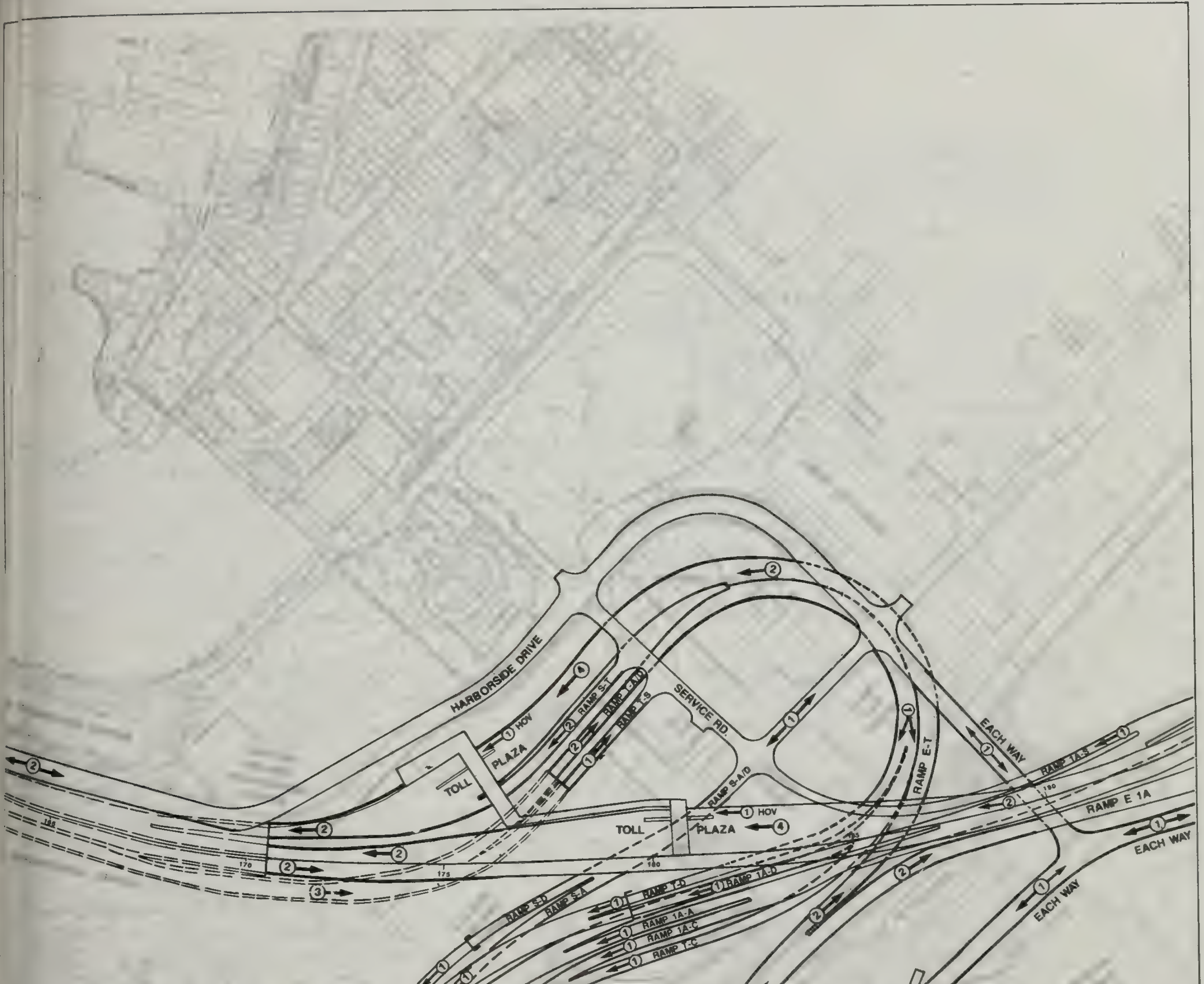
In the South Boston alternative, directional signs would be needed along the approach to the toll plaza to enable the driver to make lane change decisions prior to the split between the Seaport Access Road and the off-ramps. The curved approach, transition from tunnel to daylight, and location of the toll booths upstream of the split would make signage and driver's responses difficult.

In the Logan Airport alternative, no directional decisions would be required at the toll plaza, and a longer transitional area for lane changes would be made available.

3.3.1(c) Traffic Operations

Projected year 2010 traffic volumes travelling westbound through the Third Harbor Tunnel would be the same for either toll plaza location: 3,400 vehicles in the AM peak hour and 3,300 in the PM peak hour. Traffic from Route 1A accounts for 64 percent of the traffic in the morning peak hour (2,180 vehicles) and 46 percent in the afternoon peak hour (1,520 vehicles). The balance of traffic in each peak hour would approach the tunnel from the Logan Airport ramps.

Portal control at Logan would be required in either alternative to regulate traffic entering the Third Harbor Tunnel in order to optimize traffic flow between airport ramps and Route 1A during periods of congestion. Metering would result in queuing of traffic to approximately the same extent in either alternative.



FIGURE

3.2

East Boston Toll Plaza

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 100 200 400 800
FEET

An analysis of predicted traffic speeds shows the effects of the toll plaza location; westbound traffic speeds would be lowest in the PM peak hour when traffic volumes are highest. In the Logan Airport alternative, PM peak hour traffic from Route 1A would travel at the average speeds shown in Table 3.1.

Travel speeds would be essentially symmetrical in the two alternatives (slight differences in speed over the segments containing the toll plaza in each alternative are due to averaging the same toll collection delay over the segments of different lengths). In the Logan Airport alternative, the average speeds would be reduced for airport-related traffic as vehicles stop for toll collection and portal control, but traffic would be free-flowing through and beyond the tunnel. In comparison, with a South Boston toll plaza, vehicles would be slowed less at Logan Airport by portal control but required to stop again in South Boston for toll collection. A toll plaza at Logan would not cause greater queuing there, because (except for short queues typical of toll booths) it is portal control -- not toll collection -- that determines whether a queue would form and the length of the queue. The above analysis applies to the heavy volumes of the PM peak hour; queues would be shorter at other times, and during many hours of the day traffic metering would not be required.

In summary, traffic operation would be more efficient during congested periods with the toll plaza at Logan Airport, which combines metering and toll collection with little additional loss of speed, as compared to the South Boston alternative, in which westbound traffic would be forced to stop twice -- at the portal metering point at Logan Airport and at the toll plaza in South Boston. The superiority of the Logan alternative would be greatest during heaviest traffic conditions or during bad weather. If toll booths were to malfunction, the Logan toll plaza would permit easier handling of such conditions.

During uncongested periods, there is no significant difference in traffic operations for the two alternatives. Toll plaza alternatives affect eastbound operations only with regard to incident management, which can be better performed with the toll plaza at Logan Airport.

3.3.1(d) Enforcement

The Logan Airport toll plaza would allow implementation of traffic metering and achieve HOV priority using the same police presence needed for toll enforcement. The South Boston alternative would require separate policing for each function.

3.3.1(e) Traffic Control, Incident Management, And Emergency Response

In the South Boston alternative, the limited storage distance from the Third Harbor Tunnel portal to the toll booths would result in queues back into the tunnel during periods of heavy flow or bad weather, increasing the likelihood of vehicles stalling inside the tunnel. The curved approach to the South Boston toll plaza would likely result in unequal queues in the approaching tunnel lanes, reducing the effective capacity of the toll plaza.

The Logan Airport toll plaza would make it possible to balance the separate queues from Route 1A and the airport egress ramps. Since the regional through traffic and airport traffic reach peak conditions at different times, this advantage is expected to be used regularly.

"Incident management" refers to both emergency response to incidents such as collisions and fires as well as breakdowns which cause traffic backups. Quick response to incidents is

Table 3.1

ESTIMATED AVERAGE WESTBOUND TRAFFIC SPEEDS (MPH) IN PM PEAK HOUR, YEAR 2010

	Toll Plaza Location	
Highway Segment	**Logan Airport**	**South Boston**
Route 1A split to tunnel entrance (1,520 vehicles):	17	35
Factors:	(Tolls, Metering)	(Metering)
Airport egress to tunnel entrance (1,780 vehicles):	24	24
Factors:	(Tolls, Metering)	(Metering)
Third Harbor Tunnel:	35	35
Factors:	(Free-flow due to metering)	
Tunnel exit to off-ramps in South Boston:	35	20
Factors:	(Free-flow)	(Tolls)
Overall average speed: Traffic from Route 1A	33	20

Source: Bechtel/Parsons Brinckerhoff

thus important both for safety reasons and for maintaining traffic flow. With a Logan Airport toll plaza, it would be easier to close and evacuate the westbound tunnel in the event of a serious incident such as a fire; this is because the toll plaza upstream of the tunnel portal would provide sufficient maneuvering room for evacuating vehicles to reverse direction with the help of emergency personnel. In the South Boston alternative, queues at the east tunnel portal would be more difficult to reverse.

In the Logan Airport alternative, it also would be possible to close one westbound lane temporarily, permitting quicker response to less serious problems.

3.3.1(f) HOV Systems

The HOV system proposed as a part of the Artery/Tunnel Project will use a series of HOV lane segments to bypass areas of congestion. Since the Third Harbor Tunnel will be limited to two lanes in each direction, HOVs would be permitted to bypass queues, and metering would be used to maintain free flow in the tunnel where HOVs are mixed with other traffic.

In the South Boston alternative, the limited distance from the Third Harbor Tunnel portal to the toll booths would result in queues back into the tunnel during periods of high volumes, making it impossible for HOVs to bypass the congested area and constraining their use of exclusive toll booth lanes.

In the Logan Airport alternative, traffic could be managed so that westbound HOVs would reach South Boston in free-flowing conditions. The Logan Airport alternative also would permit more effective use of advanced technologies, such as automatic vehicle identification devices (AVI) in the HOV lanes of the toll plaza, further improving flow. Future HOV improvements at Logan Airport can be tied directly into HOV lanes in the Logan Airport toll plaza.

In both alternatives, HOVs could bypass queues to the head of the line of traffic at the control point at the airport.

3.3.1(g) Constructibility

There is no significant difference between the alternatives in terms of construction staging, work areas, required traffic diversions, movement of materials, or required construction mitigation.

3.3.2 Environmental Issues

3.3.2(a) Air Quality Impacts

Because the location of the toll plaza would not significantly affect the overall traffic patterns throughout the network, only a localized, or microscale, analysis was conducted to determine the air quality implications of these two alternatives.

Microscale air quality modeling was performed for each alternative for the year 2010 using the Mobile Source Emissions Factor Model (MOBILE 4) and the nearest sensitive receptor locations in the vicinity of the toll plaza areas. (A description of the procedures used in completing these estimates is provided in the Air Quality Technical Support Documents.) Estimates were completed for three locations -- two in East Boston, and one in South Boston. The analysis was based on estimated traffic levels during the peak 8-hour traffic period (10 AM to 6 PM). Since the 8-hour carbon monoxide (CO) values are critical when determining compliance with the National Ambient Air Quality Standards (AAQS), only peak 8-hour values were considered for this alternatives evaluation. An 8-hour background value of 1.8 ppm was developed in accordance with procedures established with the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (DEP). In addition, as the toll plaza affects primarily inbound traffic, an 8-hour CO value based on an AM peak hour condition also was considered.

The results of the CO microscale analysis are summarized in Table 3.2. The result of the analysis is that predicted 2010 concentrations under each alternative will be substantially less than (in compliance with) the National and Massachusetts AAQS at all locations analyzed. The air quality difference between these alternatives is small and should not be considered significant.

In order to test the sensitivity of the air quality results to the assumed traffic operations, an extreme worst-case scenario also was analyzed for the Logan Airport toll plaza, assuming 5-mph travel speeds through the airport segment rather than the 17-mph average under normal peak hour conditions. This case would correspond to unusually congested conditions as might result from toll booth malfunctions, breakdowns, or extreme weather conditions, resulting in long queues. The receptor closest to the community (near the Edison Building near Maverick Street) showed that CO levels would rise from 2.1 ppm to 2.5 ppm, still well under the 9 ppm standard.

3.3.2(b) Noise Impacts

In general, areas adjacent to a toll plaza location would not experience perceptible increases in noise levels compared to an alternative without a toll plaza at the same location. This is because any noise generated at the toll plaza is offset by the reduced noise from slower traffic on the approach to the toll plaza. However, distant noise receptors perceive sound differently from a point source (vehicles stopped at toll plaza) and a line source (a stream of moving vehicles approaching the toll plaza). Beyond 200 feet from the toll plaza, the effect of the approaching vehicles at speed would be greater than that of vehicles accelerating from a stop at the toll booths. The noise levels at the distant receptor site would increase by up to 3 dBA if the toll plaza were not present, owing to the higher overall traffic speeds without the toll plaza in place.

Noise sensitive areas in East Boston include East Boston Memorial Stadium Park (noise modeling locations 11 and 30), and residences on Maverick Street (location 12), and on Cottage Street (location 38). There are no sensitive receptors within 1,000 feet of the alternative South Boston toll plaza location.

With the toll plaza in South Boston, East Boston Memorial Stadium Park would experience an increase in noise of approximately 3 dBA or less, compared to the Logan Airport toll alternative. This increase would be due to increased traffic speeds and accelerations near the transition sections and tunnel portal. However, metering of traffic entering the tunnel would reduce the comparative increase during periods of heavy traffic, and since noise abatement already has been proposed for East Boston Memorial Stadium Park, the effect on the park after abatement would be insignificant. Residences on Maverick and Cottage Streets are sufficiently far away so that there would be no perceptible difference in noise with either toll plaza location. No noise abatement would be required in South Boston under either alternative because of the absence of sensitive receptors.

Table 3.2

PREDICTED WORST-CASE 8-HOUR CARBON MONOXIDE LEVELS UNDER EACH TOLL PLAZA ALTERNATIVE[1,2,3]

(parts per million)

	Toll Plaza Location	
Receptor Location	**Logan Airport**	**South Boston**
Receptor near Hilton Hotel, Logan Airport[4]	2.7	2.7
Receptor near Edison Building, Logan Airport	2.1(2.5)[5]	2.2[6]
Receptors near Toll Plaza (at respective toll plaza locations) per alternative	2.7[7]	3.3

---

1. Eight-hour standard is 9 ppm
2. AQ values on this table include appropriate background levels
3. 2010 CO background = 1.8 ppm
4. The traffic conditions near this receptor location were assumed to be identical for both alternatives
5. Based on an AM peak condition with a worst-case (5 mph) travel speed; AM and PM traffic volumes are approximately the same
6. Level would be higher with toll plaza in South Boston due to different service road configuration near the receptor
7. Results from a receptor set back from a toll plaza in South Boston (i.e., a free-flow area) were used for this value

Source: Bechtel/Parsons Brinckerhoff

3.3.3 Land Use And Community Facilities

3.3.3(a) Land Use Impacts

This analysis is confined to the area directly affected by the toll plaza alternatives: Commonwealth Flats in South Boston, and the Southwest Service Area of Logan Airport. See Figures 3.3 and 3.4.

Existing Conditions.

East Boston: East Boston comprises a mix of airport, industrial, and commercial uses adjacent to residential, park, and neighborhood commercial uses. The proposed toll plaza location is in an area of airport services including air cargo and car rental facilities. New development at Logan Airport is planned primarily for the Bird Island Flats and North Service areas.

South Boston: South Boston is divided between the northern industrial area and the southern residential area. Recent development in the northern area has consisted primarily of renovations and/or rehabilitation of existing industrial buildings for industrial and office uses. Several major office and mixed use developments are planned in or near the area.

Impacts.

Logan Airport Toll Plaza: The Artery/Tunnel Project generally would be beneficial to the South Boston area. Substantial improvements in access, including an extension of the street grid between new Northern Avenue and Congress Street, will increase the value of the undeveloped or underused land.

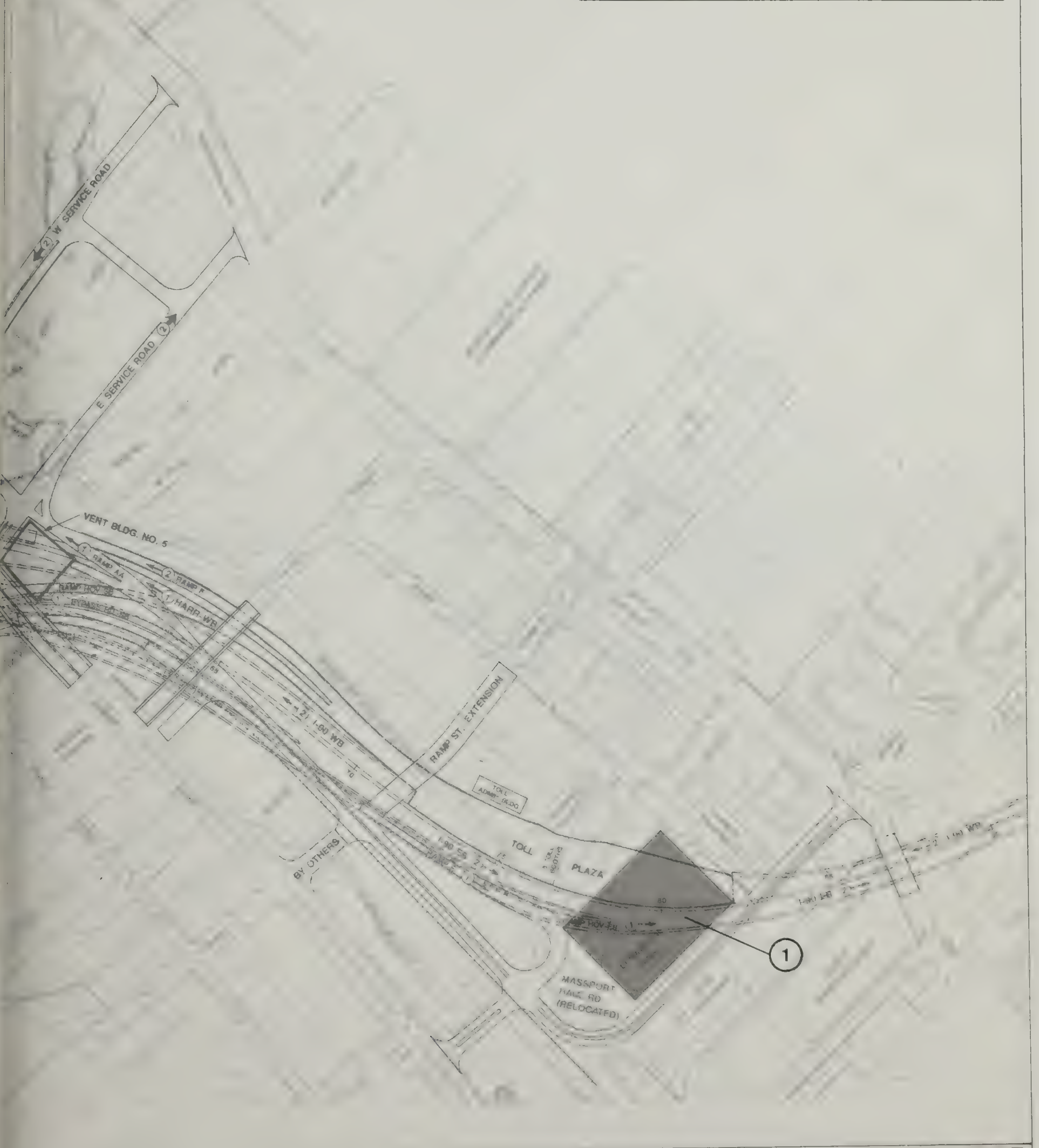
Specific land use changes at Logan Airport would include construction of a divided toll plaza with an elevated portion serving traffic from Route 1A and a portion in a depressed boat section serving airport traffic. There also would be an adjacent toll administration building, emergency response vehicle garage, and traffic enforcement center on the depressed side of the toll plaza. These facilities would not require takings of any more airport-related buildings than the South Boston toll alternative, but would occupy additional land due to the width of the toll plaza and the need for a toll administration building. No major development is planned in the area affected, and a toll plaza is compatible with airport service uses.

Specific land use changes in this alternative in the Commonwealth Flats area of South Boston include the extension of I-90 in an open boat section, and a tunnel administration building containing an operations control center. The improvements will necessitate the relocation of the Commercial Union Insurance Company and a loading dock belonging to Turner Fisheries. Future development of vacant land in this area will be constrained since these facilities occupy considerable amounts of land.

South Boston Toll Plaza: Substantial improvement to access in South Boston, including an extension of the street grid between Northern Avenue and Congress Street, would increase the value of underdeveloped or underused land. The impacts of the South Boston toll plaza alternative would be marginally greater here than the Logan Airport toll plaza, due to the somewhat larger land area occupied by the toll plaza, and a toll plaza potentially is less compatible with development planned for the Commonwealth Flats area. Takings would be as for the Logan Airport toll plaza.

LEGEND

	Facility	Use
①	30 Trillig Way	Warehouse, Distribution, Printing Service



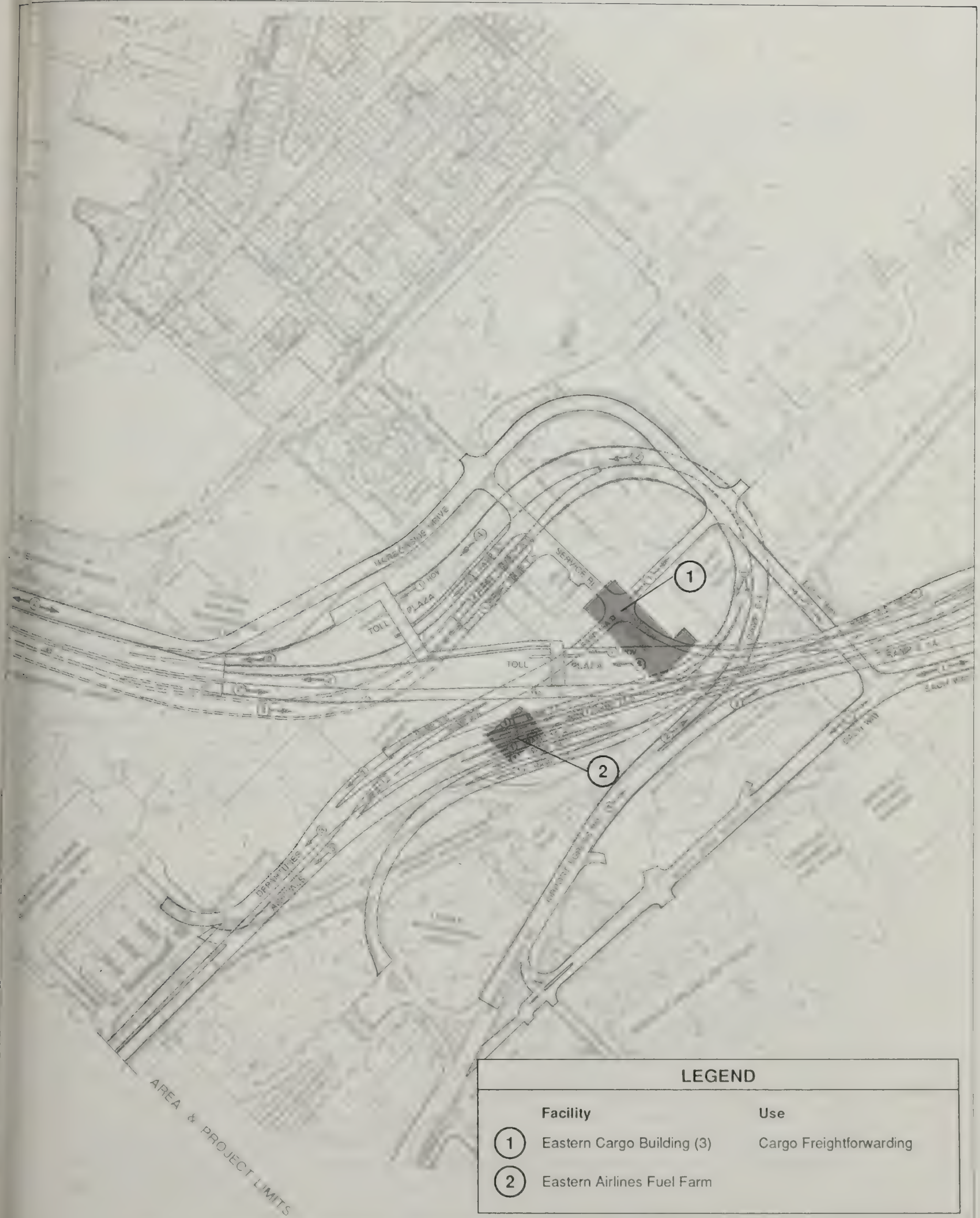
FIGURE

3.3

Relocation Impacts- South Boston And South Boston Bypass Road Area

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 100 200 400 800 Feet



LEGEND

	Facility	Use
①	Eastern Cargo Building (3)	Cargo Freightforwarding
②	Eastern Airlines Fuel Farm	

FIGURE
3.4

Relocation Impacts - East Boston/Logan Airport Area

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

At Logan Airport, the same takings of buildings would be required, but marginally less land would be occupied. This land might be usable for car rental parking or similar uses appropriate for space within a highway interchange.

3.3.3(b) Visual Impacts

Existing Conditions.

Logan Airport: From the point where the Proposed Action will join the existing airport roadway system, views will be presented of the broad expanse of large-scale airport facilities, including terminals, parking areas, and roadways. There is little pedestrian activity in the Bird Island Flats and southwest service areas at present, but such activity is expected to increase considerably following the completion of the Bird Island Flats hotel and office complex.

These areas consist of flat, open land developed with low industrial/cargo buildings, car rental storage, parking, and the new Massachusetts Technology Center office building. Most of the roadways in the vicinity of the airport are at grade; visual and pedestrian access across the airport is restricted.

South Boston: The northern portion of South Boston is generally an industrial waterfront characterized by large industrial buildings and large undeveloped areas. The BRA, Massport, the U.S. Postal Service, and several private companies plan major developments here that will change the prevailing industrial visual character by adding large-scale office and mixed use projects to this area. The new Northern Avenue bridge and realigned Northern Avenue (by others) will provide even more impressive views of downtown Boston in the future. Massport, which owns much of the property on the south side of Northern Avenue, has development plans which include a large parking garage to replace surface parking between Summer Street and Northern Avenue. The BRA plans to extend Congress Street (in a boulevard configuration) between Summer Street and Northern Avenue, and to connect the new boulevard to the proposed Ramp Street Extension. The northeastern portion of South Boston includes EDIC's Boston Marine Industrial Park, with large old industrial and distribution facilities and Subaru's large new car storage area on the waterfront.

Impacts.

Logan Airport Toll Plaza: The toll plaza would consist of two parts -- one on viaduct and one in a boat section -- connected by a bridge. Buildings in the toll plaza would be partially or entirely below grade in this part of the airport. The I-90 viaduct and elevated portion of the toll plaza would be visible from some residences in East Boston, but at typical distances of 1,000 feet or more. The toll booths, top of the administration building, and connecting bridge would be additional minor features of the airport landscape. Drivers on Route 1A southbound who choose the Third Harbor Tunnel route would continue across airport property on a viaduct to the elevated toll plaza near the existing Eastern Airlines Reservations Center. Drivers passing through the toll plaza would have a distant view of the top of downtown Boston buildings before entering the tunnel. The viaduct alignment will give the motorist on Route 1A a panoramic view of the airport and its roadway access system; this new viaduct will reinforce the northeastern edge of East Boston Memorial Stadium Park which will be expanded to the south.

Drivers from Logan Airport using the Third Harbor Tunnel would enter the depressed toll plaza from a curved boat section ramp. Here the motorists' views would be dominated by the walls of the toll plaza and, later, entrances to the new tunnel.

After passing through the Third Harbor Tunnel and ascending into South Boston, drivers would either continue on I-90 through South Boston, or leave the system either on a ramp connecting to the proposed B Street extension, or at Congress Street in the industrial section of South Boston. If current development proposals are implemented, drivers exiting the tunnel in South Boston would emerge into an area of mixed use development on a new street flanked by proposed new buildings framing a view back across the Harbor to East Boston.

South Boston Toll Plaza: The toll plaza would be in an area approximately 1,000 feet by 150 feet, and approximately 30 feet below the surrounding surface. It would be a visual gateway to motorists entering Boston from Logan Airport. Motorists' views would be of the toll plaza walls and booths, the tunnel administration building, and the open sky. Tenants of proposed future buildings in the immediate vicinity would have views down into the toll plaza.

3.4 SELECTION OF PROPOSED ACTION

3.4.1 Summary Comparison Of Toll Plaza Alternatives

The Logan Airport toll plaza location is superior to the South Boston alternative in terms of geometric criteria, toll plaza operations, signage, traffic control, and safety. The HOV system would operate much better with the Logan toll plaza. In this location the HOVs will have the opportunity to bypass other traffic entering the Third Harbor Tunnel and to avoid queuing at the South Boston end of the tunnel, which would hamper HOVs from separating from other traffic in the South Boston toll plaza alternative. In addition, locating the toll plaza at Logan improves the geometry of the South Boston interchange, benefiting both HOVs and other traffic.

Incident management and emergency response are better managed with the toll plaza upstream of the tunnel at Logan. The split toll plaza at Logan permits queues to be balanced between Route 1A and the airport in periods of heavy traffic. The Logan Airport toll plaza would provide more room for traffic control necessary for metering and giving HOVs priority.

Overall westbound travel time through the area affected by the two toll plaza alternatives would be approximately equal, although the Logan toll location would give a slight advantage during periods of heavy traffic by combining traffic metering with toll collection, while the South Boston toll plaza would require metering at Logan and a second stop for toll collection.

There are only marginal differences in the predicted environmental impacts of the toll plaza alternatives. Air quality at the edge of the airport would be approximately the same for the Logan toll plaza and the South Boston toll plaza; no violations of 8-hour air quality standards would occur for either alternative. There would be slightly more noise impact to East Boston Memorial Stadium Park with the toll plaza in South Boston because of higher traffic speeds near the park. Land use impacts would be almost identical, although future development near the South Boston location might be more sensitive to the visual impacts of a toll plaza than the airport land uses near the Logan Airport location. Visual impacts to Logan Airport and East Boston would be nearly the same for both alternatives because of the long distances presented to observers and the relatively small scale of toll facilities compared to the roadway structures common to both alternatives. Relocation needs would be identical for the two alternatives. There would be no impacts by either alternative on water bodies, wetlands, wildlife, and historic or archaeological resources.

Overall, the environmental consequences of the Logan alternative would be approximately equal to those of the South Boston alternative in terms of air quality, land use, and visual impacts; the Logan toll plaza would be slightly superior with regard to noise impacts.

In summary, the presumed benefits of locating the toll plaza in South Boston in alternative 5A Modified are not demonstrated by air quality and noise analysis, and the Logan Airport toll plaza clearly would be operationally superior, both for general traffic and HOVs, compared to the South Boston alternative.

3.4.2 Selection Of Proposed Action

Based on the above considerations, it is concluded that the Logan Airport location is the preferred alternative for the location of the I-90 toll plaza. Therefore, it has been added to the Proposed Action described in Part I of the SEIS/R.

Chapter 4 – Materials Disposal

Chapter 4
MATERIALS DISPOSAL

4.1 INTRODUCTION

4.1.1 Purpose Of This Chapter

This chapter describes and assesses the sites and alternatives considered to determine a materials disposal program for the Artery/Tunnel Project. Material disposal was an issue identified in the 1985 FEIS/R as needing further investigation. The purpose of the materials disposal program is to provide permanent disposal of the dredged and excavated material removed from the alignment of the Third Harbor Tunnel (I-90) and the depressed Central Artery (I-93). An initial part of this program is the effort to quantify and characterize the physical and chemical composition of materials to be disposed of. This chapter describes the process to date for characterizing the materials to be disposed of, and determining the options which are potentially available for materials disposal, reviews the environmental impacts of options, and identifies a preferred option.

The basic objectives for the materials disposal program include:

- The program must provide for disposal or reuse of all materials generated by the project.
- The program must be consistent with overall project purposes.
- The method and location of materials disposal must be environmentally sound and must minimize impacts to the environment.
- The program must not exacerbate existing environmental problems and, if possible, it should provide for disposal in ways that are beneficial to the environment.
- The program must be compatible and consistent with other environmental actions such as the Boston Harbor Cleanup.
- Discharge of dredged and fill material must be consistent with Clean Water Act requirements including selection of the practicable alternative having least adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. Discharge must also comply with provisions of the Ocean Dumping Act.

Within the context of these basic objectives, alternative options for materials disposal have been developed.

4.1.1(a) Materials Disposal Requirements

Quantities and Types of Material. The Artery/Tunnel Project will generate approximately 13.5 million cubic yards (cy) of excavated and dredged material requiring disposal. The materials will be taken from all sectors of the project alignment and will be generated during the construction period from 1991 through 1998. Peak disposal requirements occur in 1994.

The two basic types of material generated by the project are those which are dredged and those which are excavated. Definitions of "dredged" and "excavated" material used herein are those established by the USACE permit program under Title 33, Code of Federal Regulations, Part 323. "Dredged" material is defined as material that is removed by any means from waters of the United States, which, by definition, include tidal and inland waters and wetlands. The remainder of the materials removed for the construction of the project is considered "excavated" material, because it will be removed by a number of means from areas landward of the mean high water line. Dredged material represents about 2.4 million cy of the total, of which approximately 201,000 cy is dredged rock; the other 11.1 million cy is excavated material.

Dredged material can be further divided into two general groups:

- o Acceptable dredged material (1.4 million cy) - meets Federal and State quality standards for ocean disposal.

- o Unacceptable dredged material (1.0 million cy) - does not meet Federal and State quality standards for ocean disposal.

Excavated material can also be divided into two general groups:

- o Native materials (4.6 million cy) - primarily clay and glacial till

- o Fill (6.5 million cy) - non-native materials and organics

These materials classifications determine the applicable disposal regulations and the types of sites where the materials can be placed.

Overall Project Context For Materials Disposal. The Artery/Tunnel Project is located in the heart of Boston: a densely built, urban environment which presents challenges and imposes constraints to operations and methods of materials disposal. Primary among these constraints are the transportation implications of the materials disposal program. Dredged and excavated materials could conceivably be removed from the project site by three means: barge, truck, or railroad. Only barge and truck options were found to be feasible (see Section 4.2.2).

The rate of removal of the material from the project site would average 15,000 cy per day for a three month period during the peak year. This is equivalent to 1,200 truck loads per day. Approximately 1.1 million truck trips would be required if all of the material were to be removed from the project area by truck. One barge carries the equivalent of 100 truckloads; therefore each barge would replace 200 truck trips (one trip in, one trip out) on the urban highway system.

The number of vehicle miles travelled for disposal (the number and length of truck trips) will determine direct air quality impacts of the materials disposal program. Any speed reductions caused by entry of loaded dump trucks into traffic streams would cause secondary air quality impacts. There is also the potential for particulate emissions from excavated materials being transported by truck, particularly for longer trips.

The project schedule, consistent with overall project purposes, requires that excavation be performed over the entire project two shifts per day, with the exception of the Central Artery where three shifts per day are required. The congested urban setting in which the project is to be constructed precludes temporary storage or stockpiling of material to be disposed. There is essentially no capacity for storage of materials through most of the project alignment. Most of the material to be removed cannot be used for backfill purposes because it lacks the necessary engineering characteristics to stabilize the backfilled structures. Where excavated materials do have appropriate engineering characteristics for backfill, they will be reused by the project, but these volumes will be quite small. The materials disposal program must therefore be able to remove all materials from the project area as they are dredged or excavated. In addition, there is insufficient space at the project site for dewatering of any dredged material.

As described in greater detail in Section 4.2.4(d) below, during the excavation process, the separation of different types of material is technologically difficult. The fill material consists of mineral soil mixed with a wide range of materials that were historically deposited along the margin of Boston Harbor to create dry land on which the city could expand. Generally speaking, this type of material, because of the great variations of constituents in short horizontal and vertical distances, will need to be excavated as one type. In some instances it may be possible to differentiate this general type from the underlying native clays and glacial till because of their recognizable physical characteristics and to predict the interface such that the native clays and glacial till can be separated during the excavation process. However, the space constraints at the excavation sites will make this separation of material types difficult, and the materials disposal system must be able to accommodate the transport of the two types of materials.

4.1.2 Basis For Developing Disposal Options

The materials disposal program must provide for the disposal of all types, qualities, and quantities of materials at appropriate sites.

4.1.2(a) Generic Description Of Disposal Site Options

Several types of disposal sites could potentially be included in the materials disposal program. Each type has specific advantages and disadvantages for use, can accept different types of materials, and is regulated within a different framework. The characteristics of each type of site are briefly described below:

Existing Disposal Sites. Existing permitted (open) landfills have limited capacity for additional waste materials, and consultations with DEP indicated that use of these scarce sites should be limited. An estimated 379,000 cubic yards of project soil can be disposed at existing landfills. These soils will be excavated mainly in the early project schedule, during the utility relocation process. They will be disposed by contractors at approved disposal sites to be identified through a competitive bidding process. In addition, there is the potential for using the acceptable clay and till to be excavated (approximately 3.5 million cubic yards) to cap existing sanitary landfills which are being closed. However, the majority of project soils will have to be disposed at a new site or sites.

New Disposal Sites.

Inland Disposal Sites: These sites are sufficiently removed from the coastal marine environment so that drainage from each site enters a freshwater ecosystem. Inland disposal sites can be reached by truck or sometimes by railroad. Important issues relating to use of inland sites are impacts on water quality and freshwater wetlands, and impacts of truck trips on the regional transportation system and local streets, and operational air, noise, and other construction impacts on communities near the sites.

Coastal Disposal Sites: These sites drain into the marine environment without passing through a freshwater ecosystem. Coastal disposal sites can be reached by truck and, in some cases, by barge. Important issues relating to use of coastal sites are impacts on salt water wetlands, water quality, the transportation system, and communities near the sites. Salt contamination from the project materials is of less concern at these sites because of the similar content of the soils.

Subaqueous Disposal Sites: These sites include land under coastal waters which are naturally, or through human activity (e.g., dredging), deeper than the surrounding bottom. Subaqueous disposal sites would be served by barge. Important issues relating to use of these sites are impacts on marine habitats and water quality.

Confined Marine Disposal Sites: These are sites that are located in a coastal environment, but fill on these sites would have to be confined by structures. Confined marine disposal sites can be reached by barge, and, in some cases, by truck. Important issues relating to use of confined marine sites are impacts on marine habitats and water quality.

Ocean Disposal Sites: These are deep water sites located in the open water, without any containment structures. Ocean disposal sites can be reached only by barge. Important issues related to use of ocean sites are impacts on marine habitats and water quality.

In this report, the inland and coastal sites are also referred to as upland sites, and the subaqueous and confined marine sites are also referred to as Non-Ocean Marine sites.

Many sites of each type were identified and evaluated for the project's materials disposal program. Section 4.4 describes the site screening process which was used to develop disposal options that utilize the most feasible sites.

4.1.2(b) Federal And State Regulatory Framework

Federal and state regulations will apply to the disposal program, depending on the type of site to be used and the type of material to be disposed. A key objective in development of the materials disposal program has been to define disposal plans sufficiently to determine permitting jurisdictions and thresholds, to identify to the extent possible permit issues, and to integrate permit requirements with other environmental considerations. In addition, to comply with regulatory requirements, the program must take into consideration the full range of alternatives, including an objective evaluation of all reasonable alternatives. The potentially applicable state and federal regulations are summarized below:

- **Ocean disposal of dredged material** -- U.S. Army Corps of Engineers (USACE) permit under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972. Ocean disposal sites are designated by U.S. Environmental Protection Agency (USEPA).

- **Ocean disposal of excavated material** -- USEPA permit under Section 102 of the Marine Protection, Research and Sanctuaries Act of 1972 at sites designated for that purpose by USEPA.

- **Disposal of dredged or fill material in waters of the United States to the 3-mile limit of the territorial sea** -- USACE permit under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Massachusetts Department of Environmental Protection (DEP), Division of Wetlands and Waterways Regulations (DWWR) Waterways License in accordance with Waterways Regulations, 301 CMR 9.00. DEP Water Quality Certificate in accordance with 310 CMR 9.00 and Section 401 of the U.S. Clean Water Act, for discharge of pollutants. Massachusetts Executive Office of Environmental Affairs, Coastal Zone Management (CZM) Office Consistency Determination in accordance with CZM Regulations, 301 CMR 10.00. Local Conservation Commission, Order of Conditions under Massachusetts Wetlands Protection Act, M.G.L. c131, s40 and in accordance with Massachusetts Wetland Regulations, 310 CMR 10.00.

- **Disposal of dredged or fill materials at inland sites** -- USACE Permit under Section 404 of the Clean Water Act for disposal in inland waters and wetlands, DEP, Division of Solid Waste Management, Site Assignment under M.G.L. c111, s150A for new landfill siting of material classified by DEP as solid waste. DEP Solid Waste Permit in accordance with Solid Waste Landfill Regulations, 310 CMR 19.00, if material is classified as solid waste. DEP Water Quality Certificate in accordance with 310 CMR 9.00 and Section 401 of the U.S. Clean Water Act for discharges of pollutants into surface water bodies. Local Conservation Commission Order of Conditions under Massachusetts Wetlands Protection Act, M.G.L. c131, s40 and in accordance with Massachusetts Wetlands Regulations, 310 CMR 10.00.

- **Disposal of solid waste (historic fill excavate) subjects to USACE/USEPA Memorandum of Agreement.**

- **Point source discharge of landfill leachate** -- To surface water requires a USEPA (National Pollutant Discharge Elimination System (NPDES) permit under Section 402 of the Clean Water Act, and a DEP Division of Water Pollution Control (DWPC) Surface Water Discharge Permit under M.G.L.c.21, s43 and 314 CMR 3.00; to groundwater requires a DEP DWPC Groundwater Discharge Permit under M.G.L.c.21, s43 and 314 CMR 5.00; to construct and discharge through a sewer connection requires a DEP DWPC sewer connection permit under M.G.L.c.21, s43 and 314 CMR 7.00.

4.1.3 Organization Of This Chapter And Key Issues

Section 4.2 of this chapter describes the Project's material disposal requirements, Section 4.3 the initial survey of potential disposal sites, and Section 4.4 a process for screening candidate sites. Sections 4.5 through 4.8 discuss a full range of disposal site options considering existing conditions and environmental impacts associated with the disposal of the quantities and different types of materials. Section 4.9 identifies and evaluates combinations of sites which constitute alternative materials disposal approaches. Section 4.10 reaches a conclusion on the approach which has been selected for design study as part of the proposed action, utilizing the Massachusetts Bay Disposal Site for dredged material, the capping of sanitary landfills, and the capping and creation of parkland at Spectacle Island.

During interagency coordination regarding development of the project's materials disposal program, a number of issues have been identified by public agencies, which are addressed in this chapter. Major issues identified include:

- Some potential disposal sites that were eliminated should be examined further.
- A larger universe of disposal sites, including those investigated by MWRA for its Residuals Management Facilities, should be evaluated.
- Ocean disposal of excavated materials was not adequately evaluated as an option.
- The project should incorporate a regional disposal site for material dredged by other projects.
- The use of multiple disposal sites should be investigated.

Each of these issues has been addressed in this chapter of the SEIS/R as summarized below.

Disposal Site Screening Process. A detailed study was completed to inventory potential sites including the addition of a substantial number of new sites. These included the 296 sites which had been studied by MWRA, 523 sanitary landfills, 27 Artery/Tunnel Project sites (from the Disposal Site Screening Report), and 5 sites identified by real estate brokers, for a total of 851 sites. Of these, 3 sites were ocean, 11 were non-ocean marine sites, and 839 were inland sites. See Section 4.3 below.

As an outcome of this study, the beneficial use of 3.5 million cubic yards of acceptable clay and till to cap coastal landfills was developed.

These 851 potential sites were then evaluated for their availability, logistical feasibility, conformity to project objectives, cost, and other practicability considerations. See Section 4.4 for a description of the screening criteria and process, and Section 4.8 for results of the screening processed.

Ocean Disposal. Ocean disposal of the Artery/Tunnel Project excavated materials was evaluated. Testing of potentially floatable materials to be found in the historic fill indicates that Federal dumping regulations may be violated if this material were dumped in the ocean. See discussion in Section 4.8.3(a). It is possible that clean clay and till would be acceptable for ocean disposal, but the beneficial use of these materials to cap coastal landfills is a practicable and less environmentally damaging option (see Section 4.8.5.)

Regional Disposal Site. Discussions about developing a disposal site for material dredged by a variety of projects throughout the region have been held with several agencies. Although small amounts of dredged material from outside the project could be handled, a meaningful regional disposal site would require creation of a separate disposal cell. However, the option of a regional disposal site would be beyond permissible federal highway funding.

Multiple Disposal Sites. The use of multiple disposal sites has received considerable attention. As described in Section 4.9, use of Spectacle Island for most fill, clay, till and unacceptable dredged material has been specifically evaluated in comparison to and in combination with multiple inland sites. Investigation of inland alternatives was undertaken as required by the Corps of Engineers under the 404(b)(1) process, which requires consideration of whether inland alternatives with lesser aquatic and other significant environmental impacts are available to reduce disposal in water. The analysis presented in this chapter concludes that use of Spectacle Island for most materials is the most practicable and also the most environmentally beneficial approach.

4.2 DISPOSAL METHODS, LOGISTICS AND MATERIAL CHARACTERISTICS

This section describes the factors considered in evaluating alternative material disposal methods involving construction areas, transportation, and material quality and quantities.

4.2.1 Artery/Tunnel Project Construction Areas

For purposes of this discussion of the material disposal process, the Artery/Tunnel Project alignment has been divided into nine areas with boundaries established according to construction methods to be used (excavation or dredging), modes of site access, project planning and scheduling, physical site limitations, contract size limitations, and other common characteristics. Each of these nine construction areas contains different types of material to be disposed and has different inherent constraints on the modes of access which can be used to transport materials from the site which influence their practicability.

The nine construction areas are shown in Figure 4.1 and are described below:

- Third Harbor Tunnel Area (harbor dredging, plus dredging of areas on Bird Island Flats and at the Subaru Terminal as a part of the tunnel construction process)
- East Boston Area (excavation not including area dredged for Third Harbor Tunnel)
- Charlestown and Cambridge Area (excavation area north of Charles River)
- Charles River Area (dredging only)
- Central Artery North Area (excavation contracts will be bounded by the Charles River and North Street because of constraints on truck crossings at North Street)
- Central Artery South Area (excavation from North Street to Kneeland Street)
- I-93/I-90 Interchange Area (excavation)
- Fort Point Channel Area (dredging in Channel and graving basin on South Boston side)
- South Boston Area (excavation not including area dredged for Third Harbor Tunnel)

4.2.2 Transportation Methods And Materials Movement Options

The transportation of materials to be dredged or excavated comprises two basic operations that can be performed by different transportation modes. The two basic steps are:

- o Removal of materials from the site.
- o Transport of materials from the site to the disposal area.

These two operations present different requirements for the materials disposal program. The choice of appropriate mode is dependent on three sets of factors: (1) the project site area from which the material is being removed; (2) the site to which the material is being taken; and (3) the handling and transportation methods available or which can be developed with practicability.

The options which can be used for transport of materials are the following:

- o Truck
- o Barge
- o Railroad
- o Conveyor system

(The conveyor system has limited application and can only be used in conjunction with one or more of the other transportation modes.)

The combinations in which these transport options can be used are as follows:

- o Excavated Material
  - Truck to Disposal Site
  - Truck (or Truck to Conveyor) to Barge to Disposal Site
  - Truck (or Truck to Conveyor) to Railroad to Disposal Site
  - Truck (or Truck to Conveyor) to Railroad to Truck to Disposal Site
  - Truck to Barge to Truck to Disposal Site

- o Dredged Material
  - Barge to Disposal Site
  - Barge to Truck to Disposal Site

Four of the options involve additional handling -- truck to railroad, truck to railroad to truck, truck to barge to truck, and barge to truck -- and are undesirable because of unreasonable costs and operational constraints, as discussed below.

4.2.2(a) Movement Of Excavated Material By Rail

Four railroad systems were reviewed by the Artery/Tunnel Project for feasibility to move excavated soil to upland disposal locations. None is practicable. The following is a brief description and evaluation of these facilities:

East Boston. The existing Boston and Maine railroad facilities in East Boston extend south to Boston Harbor; however, the railroad system south of Orient Heights has not been used for at least 15 years. Approximately 4 acres would be required to develop a railroad

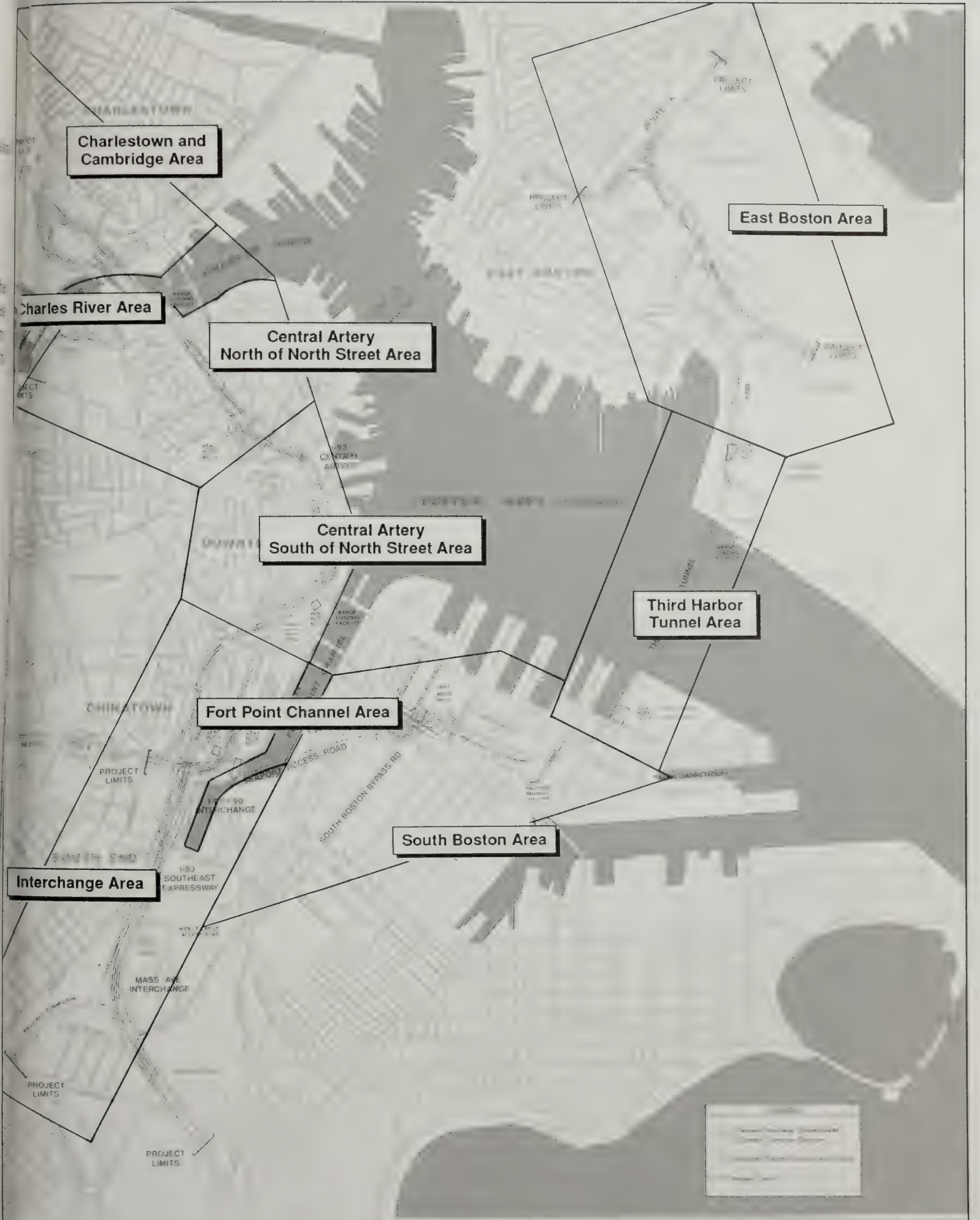


FIGURE 4.1 Project Construction Areas

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 800 1600 2400 3200 Feet

loading facility for excavated material. The only location available for this facility would be at the "Park-and-Fly" area along Bremen Street opposite Logan Airport on Route 1A. There would be difficulty reactivating the railroad between Orient Heights and the "Park 'n' Fly" area. Additionally, trucks would have difficulty crossing over Route 1A (approximately 430 truckloads per day during the 15-month period from October 1991 through December 1992) to deliver material from the point of excavation to the railroad loading facility. The dust and noise that would be associated with this operation would impact the surrounding community. Because of these difficulties, the railroad option for East Boston is not considered practicable.

Charlestown. The existing Boston and Maine commuter railroad facilities in Charlestown have been evaluated for use in removing excavated soil from the project. However, an acceptable loading area does not exist, and it would be difficult to truck the soil to this location from the Central Artery construction area. The trucks would have to pass over the North Washington Street bridge (Charlestown Bridge). The intersections at each end of this bridge are very busy and the loaded trucks would have to make a left turn through them. Interference with commuter railroad movements would also result from use of the Charlestown railyard site. For these reasons, this option was determined to be impracticable.

North Station Area. This site is impracticable for railroad transfer operations because of limited railroad capacity options and interference with commuter railroad service. Furthermore, no acceptable place for a loading facility is available in the area. About 4 acres would be required for this operation. Substantial noise impacts could be expected, especially at night.

South Station Area. This site is impracticable and was rejected for railroad transfer operations because of limited railroad capacity options and interference with commuter and interstate railroad service. Furthermore, no acceptable place for a loading facility is available. About 4 acres would be required for this operation. Substantial noise impacts could be expected, especially at night.

South Boston. The railroad system in South Boston, currently owned by Conrail, has relatively good truck access and sufficient room to load railroad cars. Extensive talks with Conrail about the use of these facilities indicate that up to two trains per day could be moved in and out of this area. Each train would have a maximum of 60 cars and each car would hold a maximum of 100 tons. Conrail cannot move more than this amount because of railroad capacity limitations and conflicts with commuter trains which would limit the time the tracks can be used for other purposes. This indicates that the train system could handle up to 12,000 tons per day out of South Boston, which is equivalent to 70 percent of the volume that must be moved from this area at the peak of excavation. Therefore, the railroad system could supplement but not replace a South Boston trucking scheme or barge movement system out of South Boston.

To determine the feasibility of such a movement, a hypothetical disposal site was assumed for an area south of Boston. It was assumed that the railroad cars would be loaded in South Boston and moved in 40-car train segments to an existing Conrail unloading yard in Walpole, where material would be unloaded by a tandem rotary car dumper, then trucked to the hypothetical landfill. (Two 40-car trains per day is the maximum number of trains that could be unloaded by the rotary car dumper.) The cost of this operation was estimated to be about three times that of trucking the material directly to the site. In addition, there is a potential major technical problem with this scheme. The Boston blue clay which is present in the excavated material would compact in the railroad cars and would not fall out when the cars are inverted by the rotary dumpers. In making the above cost estimate, it was assumed that a backhoe would be used to remove the sticky clay from the railroad cars; however, the effectiveness of this operation has not been demonstrated.

An alternative disposal site linked by railroad transport was analyzed. This alternative would transport materials, by railroad, to a remote location, such as a stripmine in western Pennsylvania. This alternative was very expensive (more than three times the cost of alternate schemes) due to the long haul distance and dump fee. In addition, there is no available technology to remove the material from the railroad cars and even if this problem could be overcome, the coal mine could only accept material at a rate of 20,000 tons per month (the rate of acceptance is dictated by the rate at which coal is excavated). In addition, it is not certain that the State of Pennsylvania environmental agencies would accept the fill material from the Artery/Tunnel Project. This option was found to be impracticable.

Based on this analysis the railroad option for South Boston was determined to be impracticable.

4.2.2(b) Movement Of Excavated Material By Truck - Barge - Truck

Another transport option for excavated soil which was found to be infeasible is the following process:

- o Truck from point of excavation to a barge loading facility and load onto a barge;
- o Move the loaded barge to a convenient unloading point;
- o Load the material from the barge onto trucks and truck to an inland disposal site.

To evaluate this scheme it was assumed that simple deck barges with 4-foot-high side boards would be used to transport the material. This means that the barges would have to be unloaded somewhere in Boston Harbor because deck barges cannot be towed into the open ocean on a continuous basis (i.e., the operation would be limited to periods of good weather, and this would place an unacceptable restriction on the construction schedule).

The following are possible barge offloading points in Boston Harbor:

- o Chelsea River in East Boston (marina)
- o Chelsea River in Orient Heights (oil terminal)
- o Chelsea River in Revere (new structure required)
- o Chelsea River in Chelsea (new structure required)
- o Mystic River in Everett (Boston Sand and Gravel area)
- o Mystic River in Charlestown (Revere/Saugus area)
- o Former Neponset Circle Drive-In Theater (MDC Park)
- o Nut Island (MWRA facilities)
- o Fore River in Quincy (MWRA shipyard)
- o Fore River in Weymouth (Edgar Station and/or Spraig Energy)
- o Back River in Hingham (Bare Cove Park)

The first six offloading points listed above are located close to major highways. The material could probably be moved from the barge offloading facility onto the highway system with very little disruption to local traffic, but the orientation of these highways dictates that the material logically must be moved north. The last six offloading points listed are located on the South Shore which would allow the material to be trucked either west or south. However, these points are not located close to major highways and therefore could potentially cause major traffic problems in the local communities.

To evaluate the cost implications of a southbound truck-barge-truck movement, a hypothetical disposal site was assumed to be located about 25 miles south of the Artery/Tunnel project. The cost of trucking 3,000,000 cy of material directly to this site would be $24 per cy. Conversely, if the same 3,000,000 cy are loaded onto barges in Boston, then offloaded from the barges in Quincy and trucked another 25 miles, the cost would be $50 per cy. The virtual doubling of cost primarily results from the double transfer of material. The truck-barge-truck option was therefore determined to be impractical because of its high cost, extra material-handling requirements, and severe traffic problems to the south on the Southeast Expressway.

4.2.2(c) Movement Of Dredged Material By Barge-Truck

For dredged material, a conceivable option would be titled "barge-to-truck-to-disposal site." However, this option is undesirable because dredged material is very wet and very difficult to handle by truck. It cannot simply be loaded into an open truck and hauled on highways because the wet material would spill over the sides and soil the highways. In addition, the dredged material contains solid objects that cannot be pumped into tank trucks. Furthermore, the transport of the water in the dredged material adds substantially to transport costs.

Dredged material must also be dewatered prior to landfill disposal. Rotary driers would be very costly and would cause particulate emissions impacts. Draining material on barge decks would be impracticable because of the lack of space at the dredging site which would be required to anchor the barges. Remote anchorage areas would be difficult to contain with silt curtains as barges would be continually entering or leaving the area. The area would require restoration at the end of this operation. The only solution is to spread the material and let it dry prior to trucking. Construction staging and replacement parking are already difficult problems because of the lack of available sites, and there are no appropriate locations within the Boston area where a barge could be unloaded and the material set out to dry. In addition, drying materials would be expected to cause particulate emissions impacts. Consequently, dewatering should be limited to coastal areas where there would be limited or no potential salt contamination problems. Therefore, this option is undesirable.

4.2.2(d) Analysis Of Methods And Materials Movement Options As To The Nine Artery/Tunnel Project Construction Areas

The remainder of the transportation options -- truck to disposal site; truck (or conveyor) to barge to disposal site; and barge to disposal site -- have been reviewed within the context of each of the project areas noted above. These analyses are presented below (see Table 4.1).

Third Harbor Tunnel. The volume of dredged material will be 1,775,000 cy (1,450 barge loads) including the quantities dredged in South and East Boston from the Harbor. The

Table 4.1

COMPARISON OF METHODS AND MATERIALS MOVEMENT OPTIONS BY CONSTRUCTION AREA[1]

			Truck	Truck to Barge		Barge
Construction Area	**Volume of Material (cy)**	**Type[2]**	**Truck Loads**	**Truck Loads**	**Barge Loads**	**Barge Loads**
Third Harbor Tunnel	1,775,000	D	N/A[3]	N/A	N/A	**1,450**
East Boston	2,200,000	E	183,000	**183,000**	**1,830**	**N/A**
Charlestown/Cambridge	84,000	E	**7,000**	**7,000**	**70**	**N/A**
Charles River	2,000	D	N/A	N/A	N/A	**2**
Central Artery North	1,515,000	E	126,250	**126,250**	**1,262**	**N/A**
Central Artery South	1,761,000	E	146,750	**146,750**	**1,467**	**N/A**
I-93/I-90 Interchange	2,326,000	E	**193,830**	193,830	1,940	N/A
Fort Point Channel	639,000	D	N/A	N/A	N/A	**533**
South Boston	2,852,000	E	237,670	**237,670**	**2,380**	**N/A**

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1. Values in bold indicate preferred transportation options based on transportation considerations alone
2. D = Dredged Materials; E = Excavated Materials
3. N/A: Not applicable

Source: Bechtel/Parsons Brinckerhoff

material would be placed directly onto barges and transported to the disposal site. As discussed above, the transfer of dredged materials to trucks is not practicable because of the need to dewater the material.

East Boston. The volume of excavated material will be 2,200,000 cy (183,000 truckloads or 1,830 barge loads). The materials removed from this project area could be taken by truck to either a barge loading site on Bird Island Flats or to Route 1A for trucking to a disposal site. (It has been assumed that trucking from Logan Airport would require a disposal site north of East Boston as it would not be acceptable to allow trucks to move south through the Sumner Tunnel into downtown Boston to reach points west and south.)

Evaluation of the trucking option suggests that impacts to the Logan roadway system would be problematic. For a period of about 15 months, the project will generate approximately 430 truck loads (thus, 860 truck trips) per day of excavated material. Assuming two shift operations, this would mean roughly one truck trip per minute which would enter the main airport roadway system, weave across four lanes of westbound traffic and again cross four lanes of eastbound traffic, and then head north via Route 1A and Bell Circle. During peak traffic hours, this addition of heavy truck traffic would exacerbate traffic problems, likely lead to additional traffic delays, cause further deterioration in air quality, and put further pressure on the local street system. From a transportation perspective, therefore, barging of materials from East Boston is the preferable method of removing materials.

Charlestown And Cambridge. The volume of excavated material will be 84,000 cy (7,000 truck loads or 70 barge loads). Materials excavated from Charlestown and Cambridge can be trucked north via Route 93 or Route 1 (it is assumed that materials would not be trucked south via the Central Artery) to a disposal site, or could be taken via the North Washington Street bridge to the a barge loading facility on the Charles River near North station (Lovejoy Wharf), which would also serve the Central Artery North segment. Another possibility is to build a small barge loading facility on the north side of the Charles River and remove this relatively small quantity of material by barge through the lock system to a marine disposal site.

Charles River. The volume of excavated material will be 2,000 cy (2 barge loads). The material would be placed directly into barges and transported to the disposal site. As discussed above, transfer of dredged materials to trucks is not practical because of the lack of opportunities for dewatering the material.

Central Artery North And South. The volume of excavated material will be the following: North - 1,515,000 cy (126,250 truck loads or 1,262 barge loads); South - 1,761,000 cy (146,750 truck loads or 1,467 barge loads). The Central Artery is the most densely developed portion of the project area and all construction must be accomplished within a tightly constrained site. The area available for staging or storage of construction materials is extremely limited in size.

There are two stages involved in the transportation of materials excavated from the Central area. The first is transporting materials from the site to either a barge loading facility or onto the regional highway system in trucks. The second is transporting materials from the project area to the disposal site.

Taking materials from the excavation site could be accomplished either by trucks or by a combination of trucks and a conveyor system. With direct truck transport, the loaded trucks would leave the construction site via the local street system and then proceed to either a barge terminal or onto I-93 for transport to inland sites. With a conveyor system, trucks would stay within the construction site and load materials onto a conveyor that would take the excavated materials to a barge terminal.

With direct truck transport, impacts to the transportation system would occur in two locations: where dump trucks enter or exit the local street system and where dump trucks enter or exit I-93. For a period of approximately 30 months, 200 truckloads per day (or 400 truck trips) would be be generated by the project in the Central North area. With 24-hour operations, this would yield about one truck trip each 3 to 4 minutes. In the Central South area, the volumes would be approximately the same. Two questions must be posed:

- o Would this volume of truck traffic adversely affect either local street operations or traffic flow on the Central Artery?
- o Can trucks reliably serve the project when they must contend with Central Artery and downtown traffic?

Truck impacts on the local street system and on the Central Artery would be associated with noise and air quality from the introduction of a new large fleet of trucks near the center of downtown Boston and on I-93.

The reliability of access to and from the construction site is of critical importance. Because there are insufficient staging areas where trucks can wait to be loaded, the project would be dependent on trucks arriving at the area of excavation with some precision. During peak hours in particular, if the trucks are delayed in traffic, there likely would be some disruption of excavation activities. It would not be possible to divert the trucks to other city streets for staging, as truck routes for the Artery/Tunnel Project will be clearly identified on project plans and observance of the plans will be strictly enforced. Staging areas located outside the City would not improve the situation as the route between such staging areas and the loading site would be subject to the same disruptions.

I-93/I-90 Interchange. The volume of excavated material will be 2,326,000 cy (193,830 truckloads or 1,940 barge loads). Materials removed from the Interchange could be taken by truck to a barge loading facility at Dry Dock #3 in the Boston Marine Industrial Park in South Boston, or can be taken by truck onto the Massachusetts Turnpike (I-90) or to the Southeast Expressway (I-93). Access to Dry Dock #3 would be via the West Fourth Street bridge, a short segment of Dorchester Avenue, and the South Boston Haul Road (the latter is to be built in advance of construction of the project as a mitigation measure.) Access to the regional highway system from the Interchange area is good. From a transportation perspective, the best method of removal is by truck to a southern or western disposal area if such suitable sites are found.

Fort Point Channel. About 223,000 cy (186 barge loads) of dredged material will be removed from Fort Point Channel. It will also remove about 416,000 cy (34,670 truck loads or 347 barge loads) of excavated material from the graving basin area on the South Boston side of the Fort Point Channel. (A graving basin is a dry excavation in which the tunnel sections are fabricated. It is subsequently flooded to allow the sections to be floated to their final locations.) As noted previously, it will not be possible to transfer the dredged material from the barge to trucks because there is not sufficient space to dry the dredged material prior to trucking. Consequently, the dredged material would be loaded onto barges, that would be moved directly to a marine disposal area.

Since the contractor will have to operate barges for the disposal of the dredged material, it would be advantageous also to load the excavated material onto barges for disposal at a marine site. This would eliminate the need to truck a relatively large volume of material (416,000 cy) through South Boston.

South Boston. The volume of excavated material will be 2,852,000 cy (237,670 truck loads or 2,380 barge loads). Material could be trucked through industrial zones to Dry Dock #3 for transfer to barges, or could gain access to I-93 or I-90 via the South Boston Haul Road, Dorchester Avenue, and the West Fourth Street bridge. Access to Dry Dock #3 would pose few conflicts with local or regional traffic, while access to the regional highway system would be circuitous and less desirable in terms of local movement of materials. Therefore, the preferred transportation option for South Boston is truck to barge.

Summary. From the perspective of impacts on local and regional roadways and on project construction activities, a number of different transportation options are preferable, depending on the construction area. The preferences noted below are based on the key identified transportation considerations alone -- only one of a number of factors that will be used to determine the practicability of disposal options.

- Third Harbor Tunnel - Barge to marine disposal site
- East Boston - Truck to barge to marine disposal site
- Charlestown and Cambridge - Truck to (north) inland disposal site (or barge to marine disposal site)
- Charles River - Barge to marine disposal site
- Central Artery North and South - Truck to barge to marine disposal site
- I-93/I-90 Interchange - Truck to (south or west) inland disposal site
- Fort Point Channel - Barge to marine disposal site
- South Boston - Truck to barge to marine disposal site

4.2.3 Material Quantities

The Artery/Tunnel Project will generate 13.5 million cy of dredged and excavated materials, which will have to be disposed away from the project site. Disposal of dredged or excavated materials is regulated under various Federal and State environmental laws and regulations including the Federal Clean Water Act and the Federal Marine Protection, Research, and Sanctuaries Act.

Table 4.2 contains a summary of the volumes of material to be dredged or excavated from each construction area. The construction areas are indicated on Figure 4.1.

4.2.3(a) Reuse Of Excavated Fill As Backfill

Approximately 4,000,000 by of backfill will be required by the Artery/Tunnel Project. Ideally, the fill and unsorted clay and till excavated from the project (7,272,000 cy) could be used for this purpose, and it would reduce the total volume of material that must be disposed. However, most of the material excavated by the project will be a mixture of clay soils, organic material, and pieces of wood and leather. Such materials are not suitable for backfill because they decompose and settle over many years.

A further discussion of the possible re-use of excavated material as backfill is contained in Section 20.1.1(f) of Part I.

4.2.4 Material Quality

An extensive soil sampling program has been undertaken to chemically characterize the material to be dredged or excavated (Soils Characterization Report, Jason M. Cortell and Assoc. Inc., May 1989). The purpose of the soil characterization program was to screen the suitability of material for disposal at various types of sites. Suitability depends on chemical characteristics, such as salt content or contaminants, and physical characteristics, such as floatability and suitability for landfill capping.

4.2.4(a) Chemical Quality Of Excavated Material

Soil samples from a 400-foot-wide corridor along the project alignment, were collected and analyzed to determine the chemical quality of excavated materials. (See Figure 4.2. Not shown in the figure are locations of borings in the Third Harbor Tunnel alignment which were taken as part of a separate program.) A total of 130 boring locations were selected within the corridor, concentrated in areas where contaminants might be present, such as industrial sites or where filling had previously occurred. The probability of detecting problem areas was thus increased compared to a random sampling approach.

A total of 256 samples were collected from the 130 borings. The soil samples consisted of miscellaneous fill, organic material, silt, sands/gravel, clays and till. The results of the program indicate that soil characteristics vary substantially over relatively short horizontal and vertical distances along the project alignment, mostly because of the extensive filling that took place during the 19th and 20th centuries (almost all of the upland portion of the alignment is through fill).

The results of the chemical analyses were used as a first level check on the quality of the materials as it relates to potential disposal options. The classification scheme established in DEP's Regulations for Dredging, Dredged Material Disposal and Filling in Waters, 314 CMR 9.00, was used to categorize levels of 10 chemical constituents into three categories of increasing concentration (see Table 4.3). In addition, an eleventh constituent -- petroleum hydrocarbons -- was developed for the Artery/Tunnel Project because of its known existence and its importance related to selection of disposal options.

Table 4.2

MATERIALS QUANTITIES BY CONSTRUCTION AREA[1]

Construction Area	Dredged (cy)	Excavated (cy)	Total (cy)
Third Harbor Tunnel	1,775,000 [2]	--	1,775,000
East Boston	--	2,200,000	2,200,000
Charlestown/Cambridge	--	84,000	84,000
Charles River	2,000	--	2,000
Central Artery North	--	1,515,000	1,515,000
Central Artery South	--	1,761,000	1,761,000
I-93/I-90 Interchange	--	2,326,000	2,326,000
Fort Point Channel	639,000 [3]	--	639,000
South Boston	--	2,852,000	2,852,000
Total	2,416,000	10,738,000 [1]	13,154,000 [1]

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1. Totals do not include 379,000 cy of excavated material removed during the utilities relocation process; this material will be disposed by contractors at approved sites to be identified through a competitive bidding process
2. Includes 509,000 cy of material to be removed by dredges in the tunnel construction process
3. Includes 416,000 cy of material to be removed by dredges in the Fort Point Channel area

Source: Bechtel/Parsons Brinckerhoff

Table 4.3

CLASSIFICATION OF MATERIAL BY CHEMICAL CONSTITUENTS

	Concentration (ppm)		
Parameter	**Category I**	**Category II**	**Category III**
Arsenic (As)	< 10.0	10.0-20.0	> 20.0
Cadmium (Cd)	< 5.0	5.0-10.0	> 10.0
Chromium (Cr)	<100.0	100.0-300.0	>300.0
Copper (Cu)	<200.0	200.0-400.0	>400.0
Lead (Pb)	<100.0	100.0-200.0	>200.0
Mercury (Hb)	< 0.5	0.5-1.0	>1.0
Vanadium (V)	< 75.0	75.0-125.0	>125.0
Zinc (Zn)	<200.0	200.0-400.0	>400.0
Hydrocarbon (HC)[1]	<100.0	100.0-500.0	>500.0

---

1. Criterion proposed by Artery/Tunnel Project

Source: 314 CMR 9.00 - Regulations for Dredging, Dredged Material Disposal and Filling in Waters

Soil samples were analyzed for sodium and other water-soluble chlorides to determine if concentrations of these constituents would constrain the disposal of excavated and dredged material at inland areas. High concentrations could potentially contaminate freshwater aquifers. The results indicate that all samples of river sediment, fill, and materials below the fill, collected from historically filled areas, contain high concentrations of sodium and chloride. It would therefore be preferable to dispose of such materials at sites draining to a marine (saltwater) environment.

In order to determine the concentration of other constituents, the entire project alignment was divided into 14 zones (see Figure 4.2). Most of the zones were further divided into three layers: upper fill, lower fill, and all materials below the fill. In this manner, the total volume of materials to be excavated was divided into 38 segments (10 zones with three layers, and four zones with two layers). Means and standard deviations of selected metal and petroleum hydrocarbon concentrations were obtained for each soil stratum of each zone, as well as for the entire project alignment. The breakdown of the alignment by zone and soil stratum is an effort to differentiate areas with higher concentrations (Category III) from zones with lower concentrations (Category II or lower). A statistical summary of this analysis is given in Table 4.4. Data on river sediments from the Charles River and Fort Point Channel are also included in Table 4.4.

The table also provides a comparison of the constituent levels to the 314 CMR 9.00 guidelines. While petroleum hydrocarbons are not specified in the 314 CMR 9.00 classification scheme, the results of the statistical analysis of this parameter are reported because of the known importance of this constituent on evaluating disposal options.

The mean of a given constituent concentration represents the average concentration among all samples taken in the studied area, zone, or horizon. The mean value is important because mixing of materials during excavation and handling will occur before disposal. The standard deviation is a measure of the variation of the samples in the area studied. A large standard deviation is an indication of large variations in the concentrations among the aggregate samples. The distribution of the data is such that additional sampling is not expected to change the mean values by much.

Only zones 1 and 13 do not contain mean concentrations of any metal falling into DEP Category III. Most of the zones have low levels of copper, and zinc. Zone 10 has high levels of zinc, and the average levels of both copper and zinc in zone 14 fall into Category III (Figure 4.3).

Statistical analyses performed independently on each of the 38 cells are summarized in Figures 4.3 through 4.8. Twenty-nine cells were found to contained at least one constituent at mean concentrations falling into Category III. Only two of 14 native material cells sampled can be rated as Category II. The remaining 12 cells were classified as Category III, primarily because of the high concentration of naturally occurring arsenic.

Extraction Procedure (EP) toxicity analysis performed on samples with elevated arsenic, lead, and mercury concentrations indicated that only one of the 64 samples tested, with 6 ppm of lead, exceeds the EP toxicity contaminant level (5 ppm of lead). The results of the soil characterization studies conducted to date indicate that project soils to be excavated are typical of those encountered in Boston or in other urban areas and that there

Table 4.4

SUMMARY OF STATISTICAL ANALYSIS OF SELECTED SOIL CONSTITUENTS

Total Tests	Mean (ppm)	Category	Standard Dev (ppm)
SOIL STRATA: Fill and Native	**ZONE:**	**Whole Alignment**	
ARSE 217	23.04	III	16.29
LEAD 217	351.00	III	705.39
MERC 217	1.65	III	5.41
HYDR 221	586.19	II	2,234.56
SOIL STRATUM: U	**ZONE:**	**Whole Alignment**	
ARSE 116	22.16	III	15.55
LEAD 116	453.90	III	796.70
MERC 116	1.68	III	4.96
HYDR 116	268.72	II	411.50
SOIL STRATUM: L	**ZONE:**	**Whole Alignment**	
ARSE 50	17.50	II	8.62
LEAD 50	391.90	III	699.63
MERC 50	2.96	III	8.18
HYDR 49	1,482.06	III	3,713.23
SOIL STRATUM: D	**ZONE:**	**Whole Alignment**	
ARSE 51	30.83	III	20.47
LEAD 51	76.85	I	327.21
MERC 51	.30	I	.97
HYDR 51	493.09	II	2,699.12
SOIL STRATUM: S	**ZONE:**	**Charles River and Fort Point Channel**	
ARSE 19	16.82	II	9.65
LEAD 19	554.98	III	384.61
MERC 19	3.89	III	5.76
HYDR 19	5,697.372	III	6,684.33

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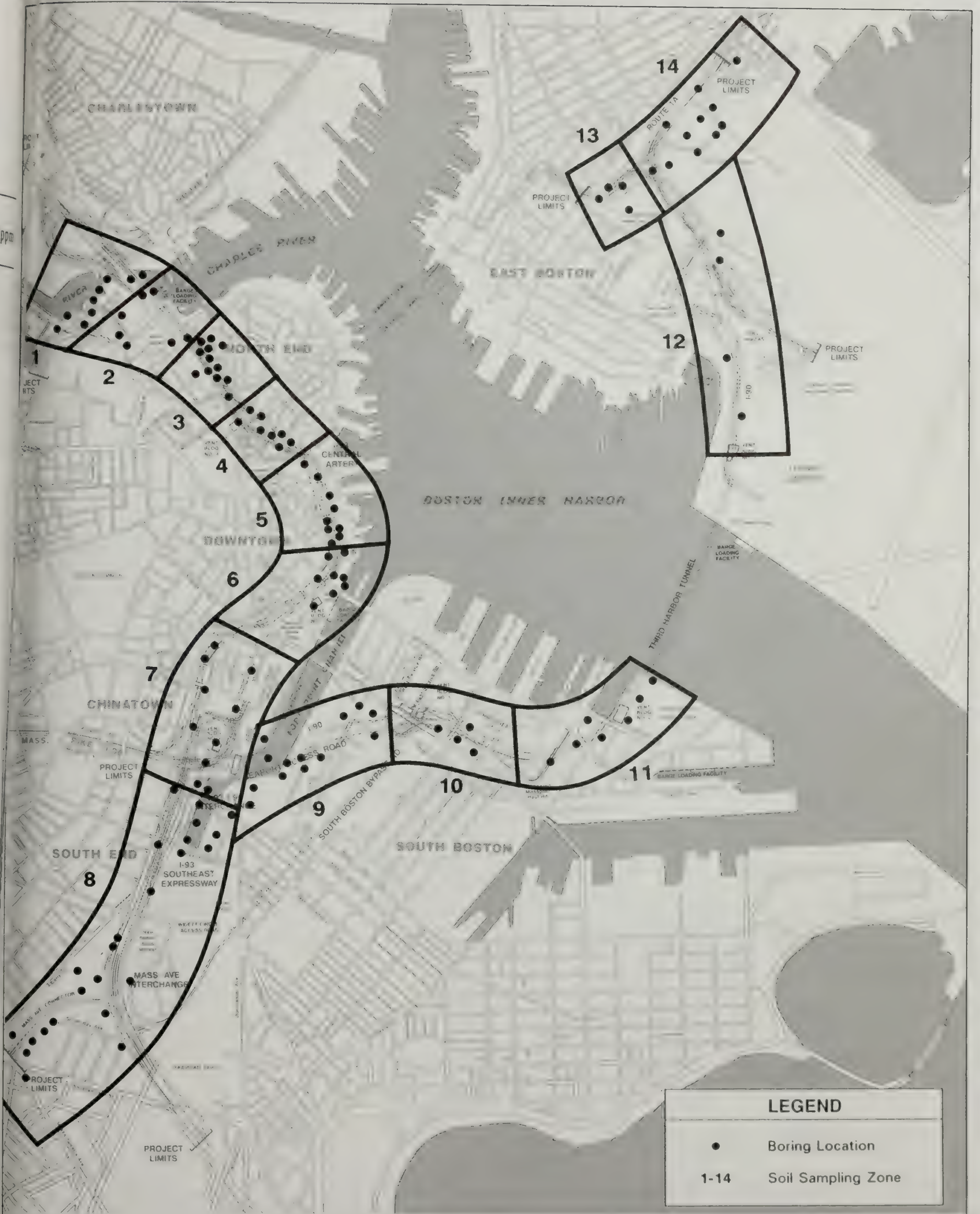
1. ARSE - arsenic; MERC - mercury; HYDR - petroleum hydrocarbons; DEV - standard deviation
2. All material - entire alignment
3. Upper fill - entire alignment (U)
4. Lower fill - entire alignment (L)
5. Native soil - entire alignment (D)
6. River sediments (S)
7. For category concentrations (ppm), see Table 4.3

Source: Bechtel/Parsons Brinckerhoff



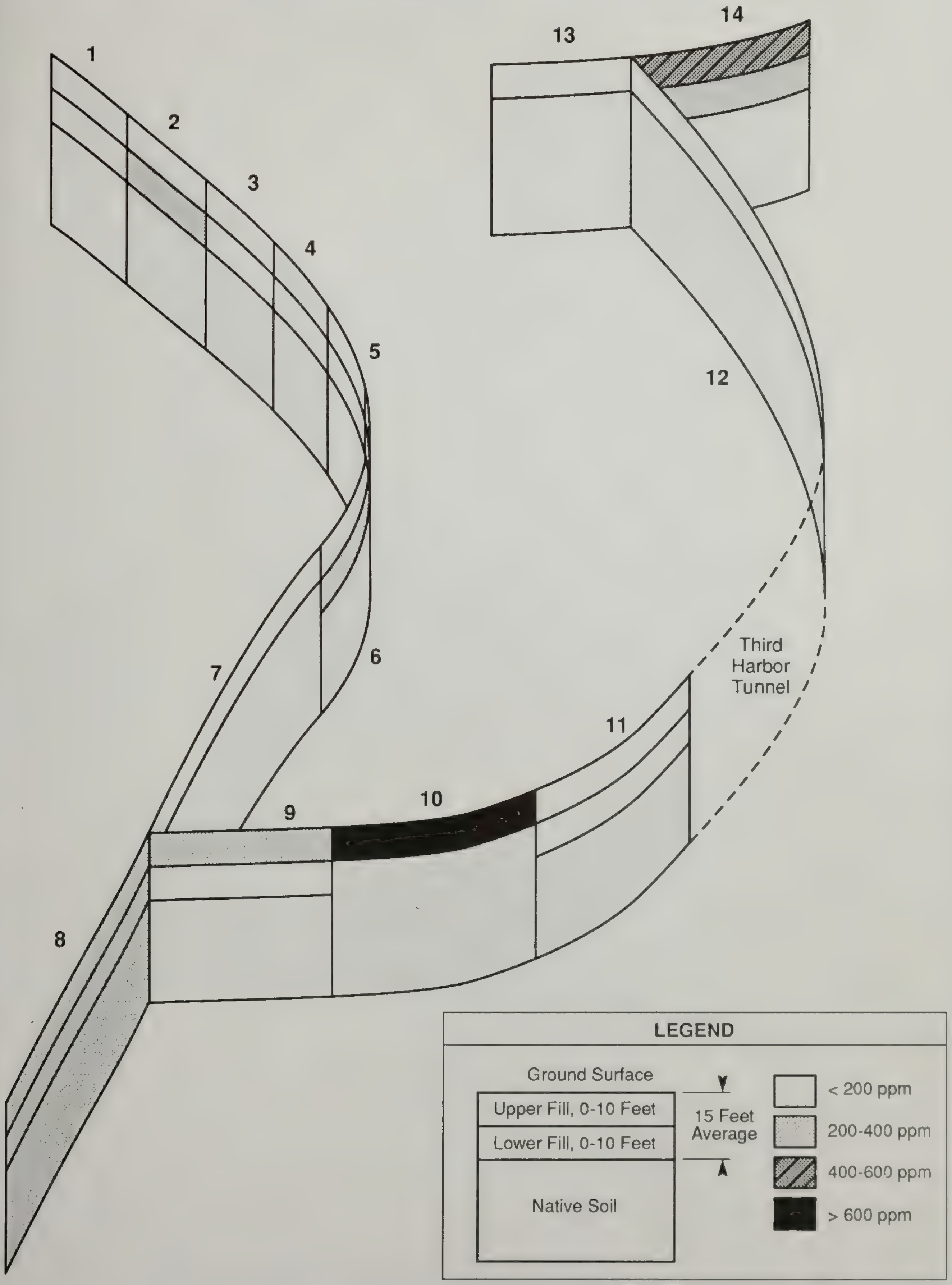
FIGURE

4.2

Soil Sampling Zones And Selected Boring Locations

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 800 1600 2400 3200 Feet



FIGURE

4.3

Zinc And Copper
Schematic Diagram - Subsurface Profile Soil Characterization

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Not to Scale

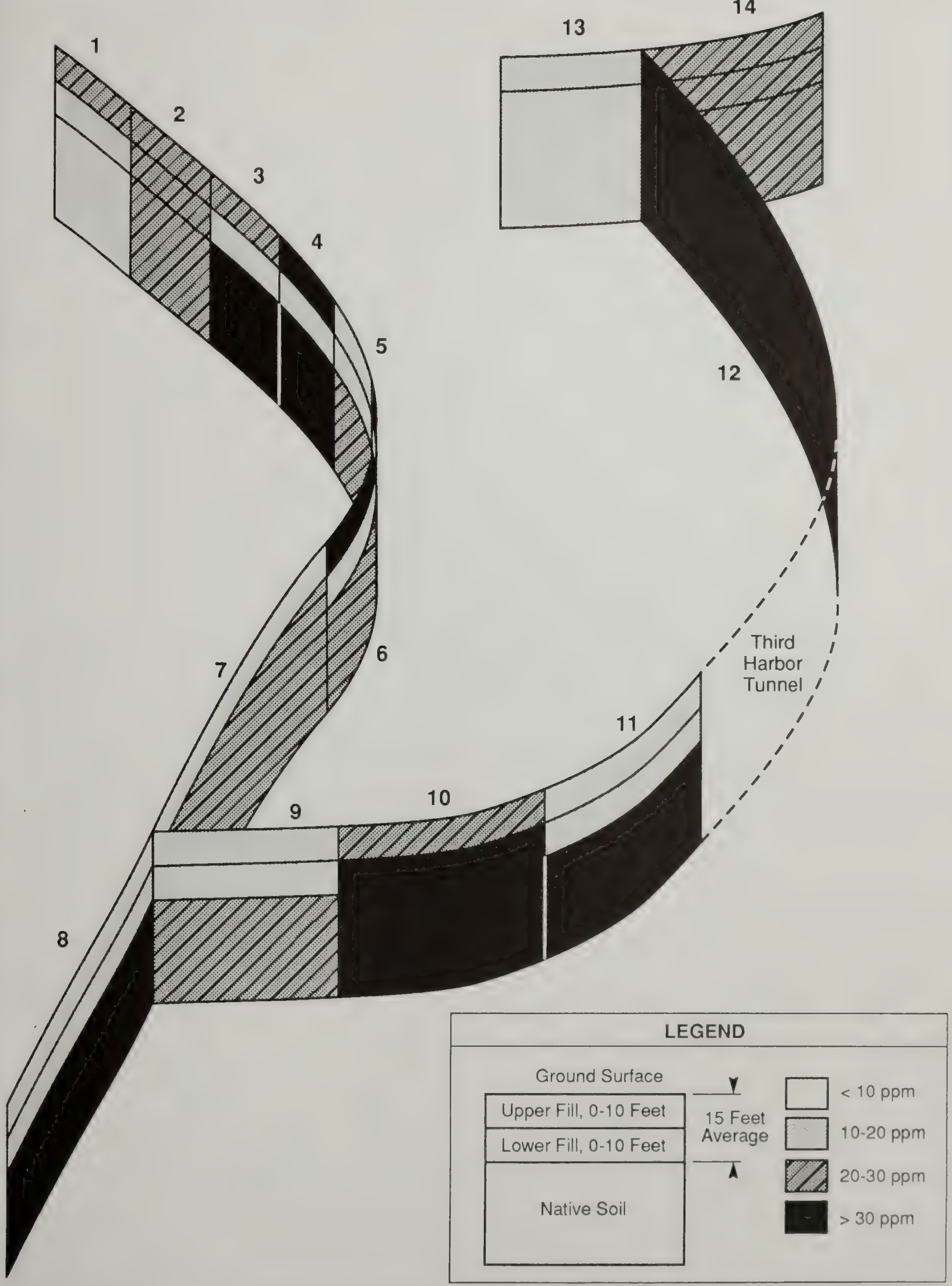


FIGURE 4.4

Arsenic
Schematic Diagram - Subsurface Profile Soil Characterization

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Not to Scale

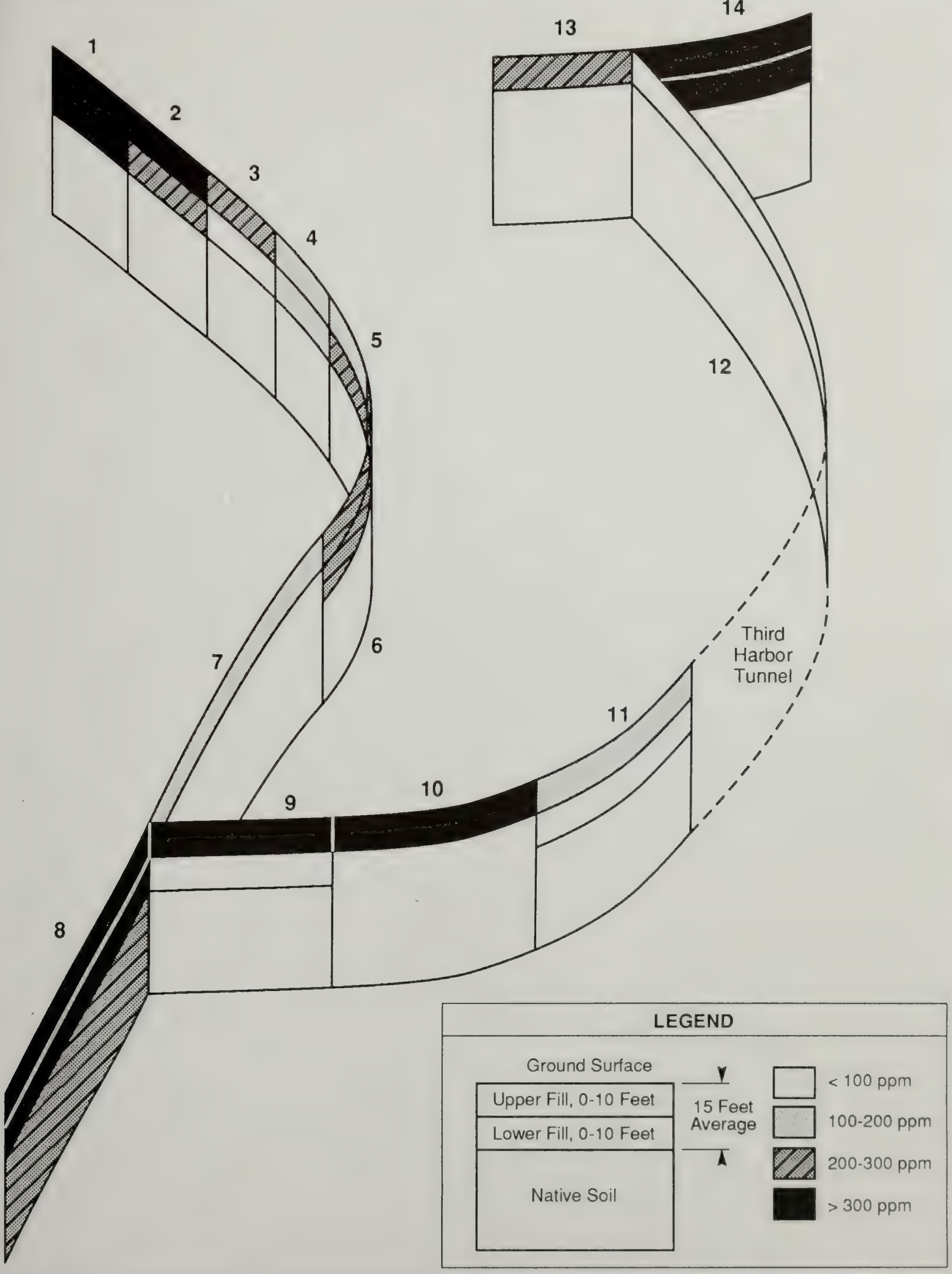


FIGURE
4.5

Lead
Schematic Diagram - Subsurface Profile Soil Characterization

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Not to Scale

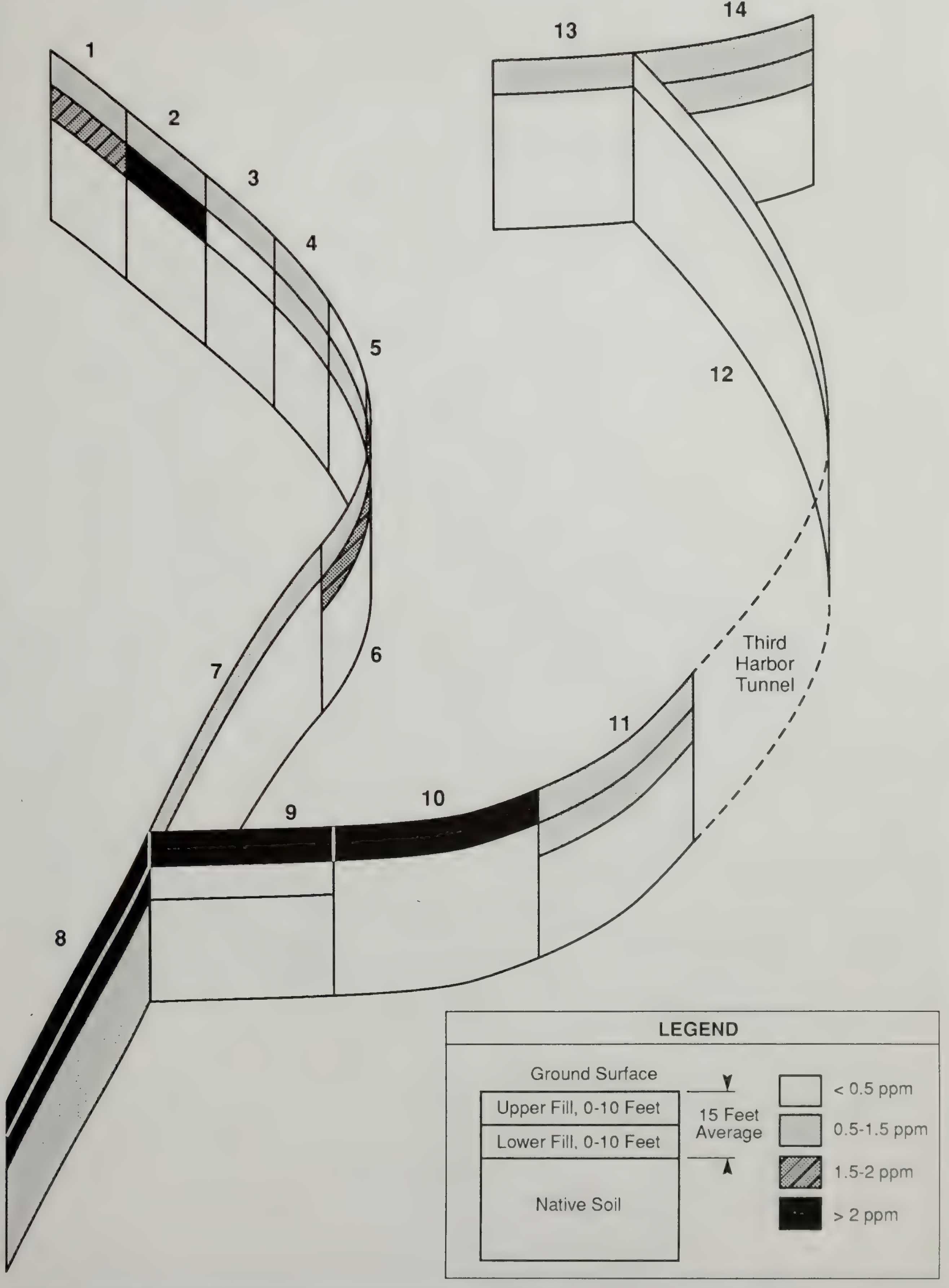
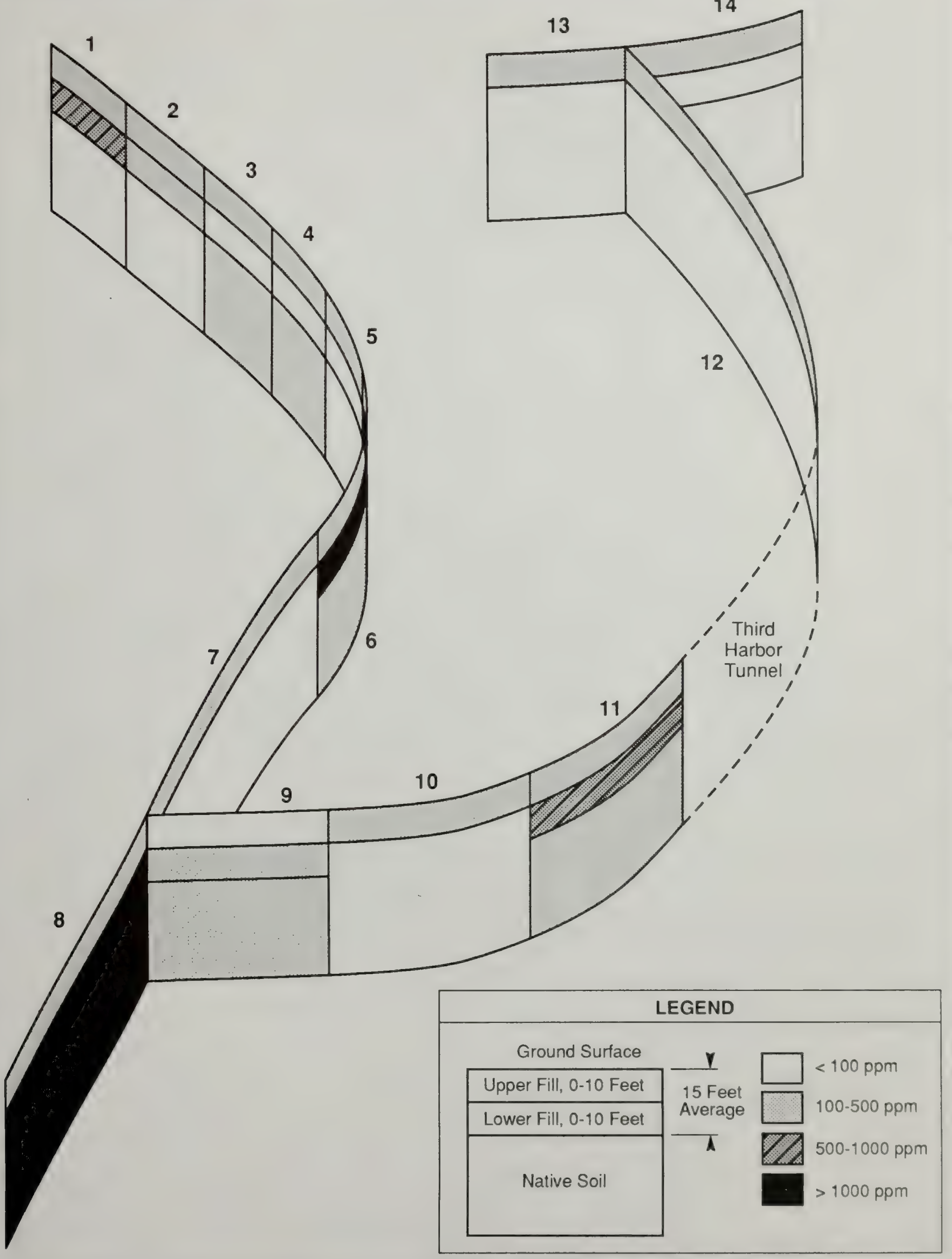


FIGURE
4.6

Mercury
Schematic Diagram - Subsurface Profile Soil Characterization

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Not to Scale



FIGURE

4.7

Hydrocarbon

Schematic Diagram - Subsurface Profile Soil Characterization

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
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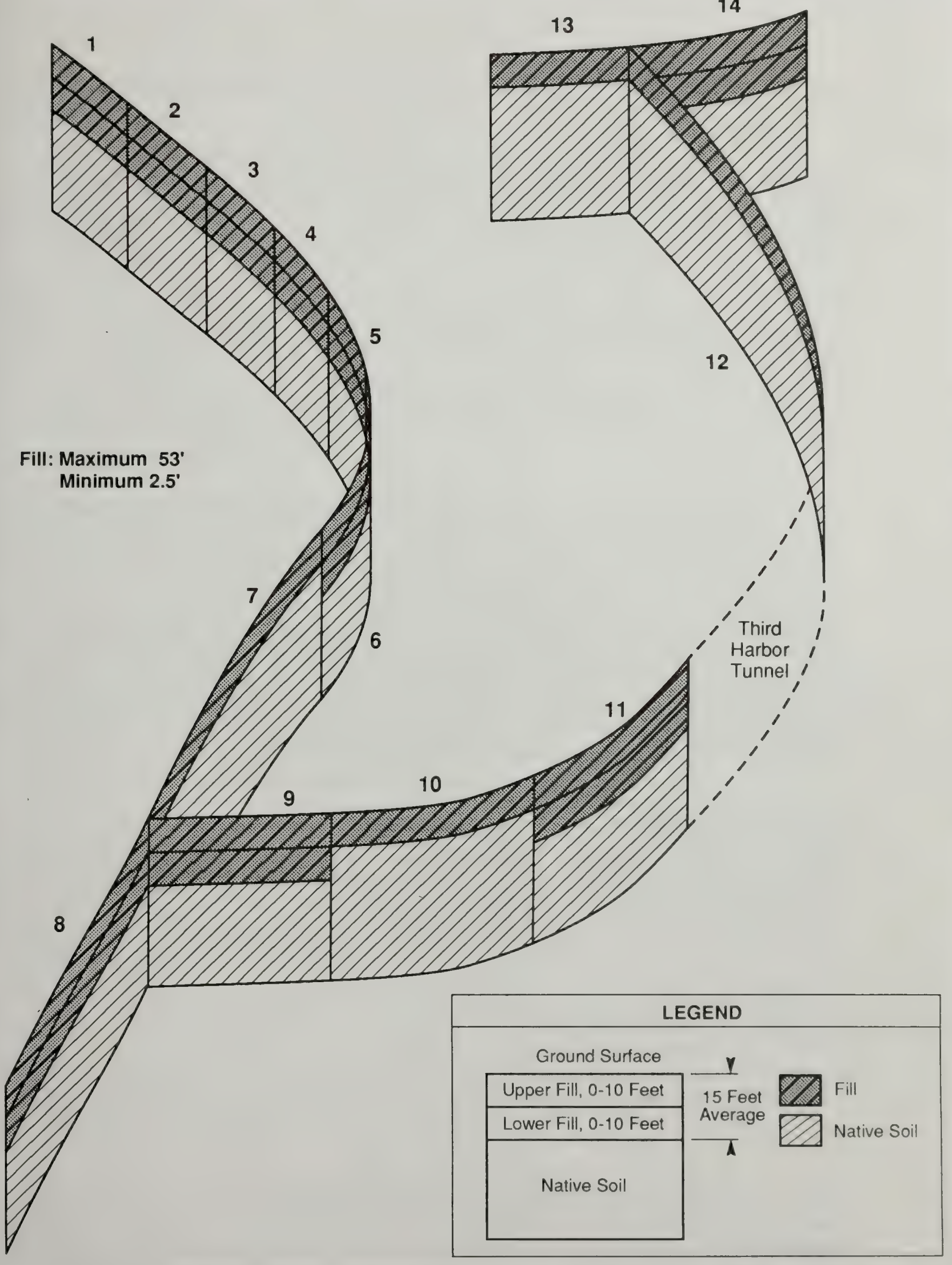

Fill: Maximum 53'
Minimum 2.5'

FIGURE
4.8 **Quality Of Fill**
Schematic Diagram -
Subsurface Profile

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SUPPLEMENTAL EIS/R

Not to Scale

would be no serious constraints to the selection of disposal options for the excavated material.

4.2.4(b) Chemical Quality Of Dredged Material

A dredged material sampling and analysis plan (protocol) was developed for materials to be dredged for the Third Harbor Tunnel between South Boston and East Boston. This construction area will generate most of the project's dredged material. The protocol was submitted to EPA, USACE, and DEP for review and comment prior to program implementation. The program is being conducted in order to determine whether the materials are suitable for ocean disposal. Bulk sediment analyses and bioassay/bioaccumulation testing were conducted in 1987. Test results established that the dredged materials for the tunnel (1,266,000 cy) are suitable for disposal at an ocean disposal site, and the USACE has made a preliminary suitability determination to that effect in correspondence to the Department dated September 22, 1988. The Massachusetts Bay Disposal Site (MBDS) would be an appropriate site for the disposal of these materials, since that site is already designated by EPA for dredged materials disposal.

Bulk sediment analyses have also been conducted on sediments in Fort Point Channel and the Charles River as part of the 1988 soil characterization program. The data indicate that the shallow sediments are contaminated with metals and hydrocarbons. Five of seven samples tested from Fort Point Channel have Category III concentrations of arsenic, lead, mercury, cadmium, copper, and zinc. Four contain petroleum hydrocarbons at concentrations greater than 1,000 parts per million (ppm), and have a mean (average) concentration of about 7,300 ppm. Similarly, Category III concentrations of lead, mercury, and petroleum hydrocarbons were found in nine of 10 of the sediment samples collected from the Charles River. Based on these nine sediment samples, average concentrations are 640 ppm of lead, 2.5 ppm of mercury, and 6,183 ppm of petroleum hydrocarbons. Approximately 140,000 cy of dredged material from Fort Point Channel may be suitable for disposal at an ocean site such as the MBDS, subject to further testing.

Additional sampling and analysis is planned on the materials to be dredged in East and South Boston for the Third Harbor Tunnel and in the Fort Point Channel area. These materials, having a volume of 925,000 cy, are situated out of the channel limits above the mean high water lines. They will have physical characteristics of the fill material described in 4.2.4(c) below. For the present document, this volume is assumed to be unacceptable for disposal at an ocean site.

In summary, 1,266,000 cy of dredged material from the Third Harbor Tunnel and potentially 140,000 cy from Fort Point Channel is acceptable for disposal in the ocean. A volume of 201,000 cy of rock is included in this quantity and this could be used beneficially elsewhere, leaving a total of 1,205,000 cy of dredged material suitable for ocean disposal. The total volume of material dredged from the project is 2,416,000 cy leaving 1,010,000 cy potentially unsuitable for disposal in the ocean (see Table 4.1).

4.2.4(c) Physical Characteristics Of Excavated Materials

Most of the project will be constructed in areas containing fill material that varies in depth from 2.5 to 53 feet, with an average depth of 15 feet. Beneath the fill layer, there generally is a narrow band of silts, muds, and sand that comprised the surface materials under the Harbor at the time of European settlement. Under these materials are extensive layers of Boston blue clay and glacial till with the clay generally overlying the till (see Figure 4.9). Beneath the till is bedrock.

When fill materials were placed in the Harbor, they mixed with the layers of muds, silts, and sands. This mixture of materials comprises approximately 6,705,000 cy of the total volume of material to be excavated. Boston blue clay and glacial till to be excavated have been estimated at 4,621,000 cy. Approximately 337,000 cy of bedrock would also be excavated.

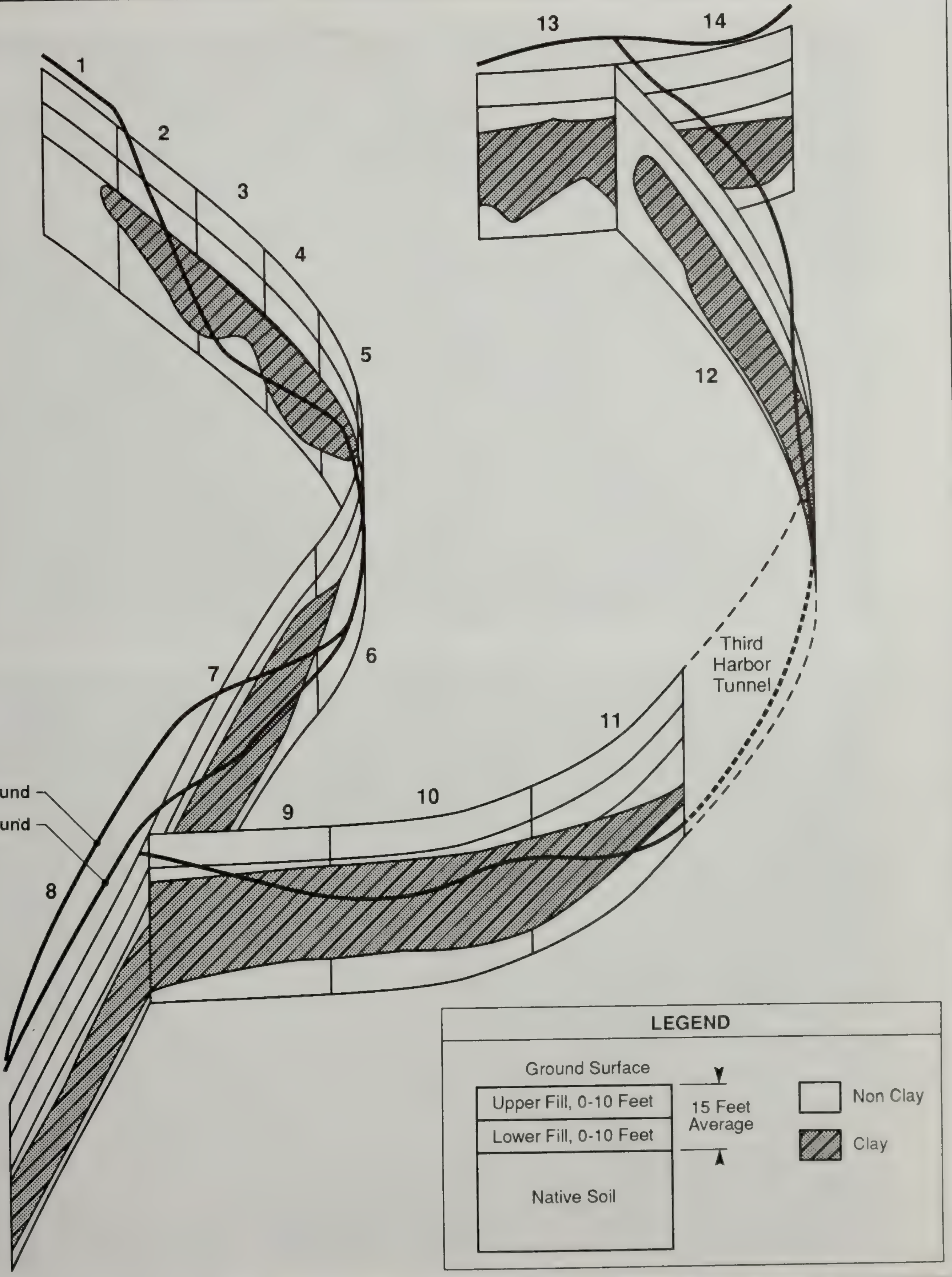
The boring logs recorded during the soil characterization program reveal that virtually all of the fill material, muds, silts and sands, contain bricks, asphalt, wood, cinders, ash, coal, ceramics, glass and leather along with sands, gravel, and other soil material (Figure 4.10 illustrates the quantity of wood encountered during excavation in the historic fill at 200 State Street beside the Central Artery.) The estimated percentage of each material type is presented in Table 4.5: wood (7 percent), coal (8 percent), cinders (19 percent) and leather (3 percent). Some of these fill materials have the potential to float if disposed in the water.

The draft report, Potential For Fill Material To Float, by Bechtel/Parsons Brinckerhoff, February 1990, describes the analysis of the fill material, the floatability tests and results.

The wood, which is in the historic fill, is miscellaneous debris from demolished buildings, refuse, corduroy roads, and buried structures such as wharves and jetties including timber piles, framing and crossbracing. Wood from various excavations on or near to the project alignment (North Station, 125 High Street, at the Summer Street/Viaduct Street intersection, and near the West Fourth Street bridge in the I-93/I-90 Interchange area) was sampled to determine if the material would, in fact, float. Immersion tests in seawater indicate that initially about 90 percent of this material will float, and that this percentage decreases to 75 percent after about 3 days and to 25 percent after 21 days. These percentages for wood can be converted into actual quantities of flotsam resulting from the disposal of the fill material in the ocean.

During the three peak years of construction, over 9 bargeloads of material per day would be taken to the disposal site. If an uncontained ocean disposal site were used, and 50 percent of this volume was fill (i.e., 6.7 million cy out of a total of 13.2 million cy) and each barge contained 1,235 cy, then 300 cy per day of wood would float on the surface of the water, at least for several days. If the project is able to remove 90 percent of the wood during the handling process (i.e., wood larger than 6 inches in diameter and over 2 feet long), then the volume would be 30 cy per day. This would translate into a daily flotsam raft about 2,900 feet long by 10 feet wide by 1 inch thick on average, allowing 200 percent spacing between the floating wood pieces. (Generally, flotsam rafts tend to be long and narrow, because of surface winds and currents.)

Similar floatability tests were performed on samples of cinders and coal. With these materials, removal is not possible during the handling process. The resulting daily flotsam for cinders would be on the order of 1,300 feet long by 10 feet wide by 0.1 tenth of an inch thick on average (0.4 percent floats, a volume of 4 cy), and about 4,500 feet long by 10 feet wide by 0.01 inch thick on average for coal (0.3 percent floats, a volume of 1.4 cy).



FIGURE

4.9

Boston Blue Clay
Schematic Diagram - Subsurface Profile Soil Characterization

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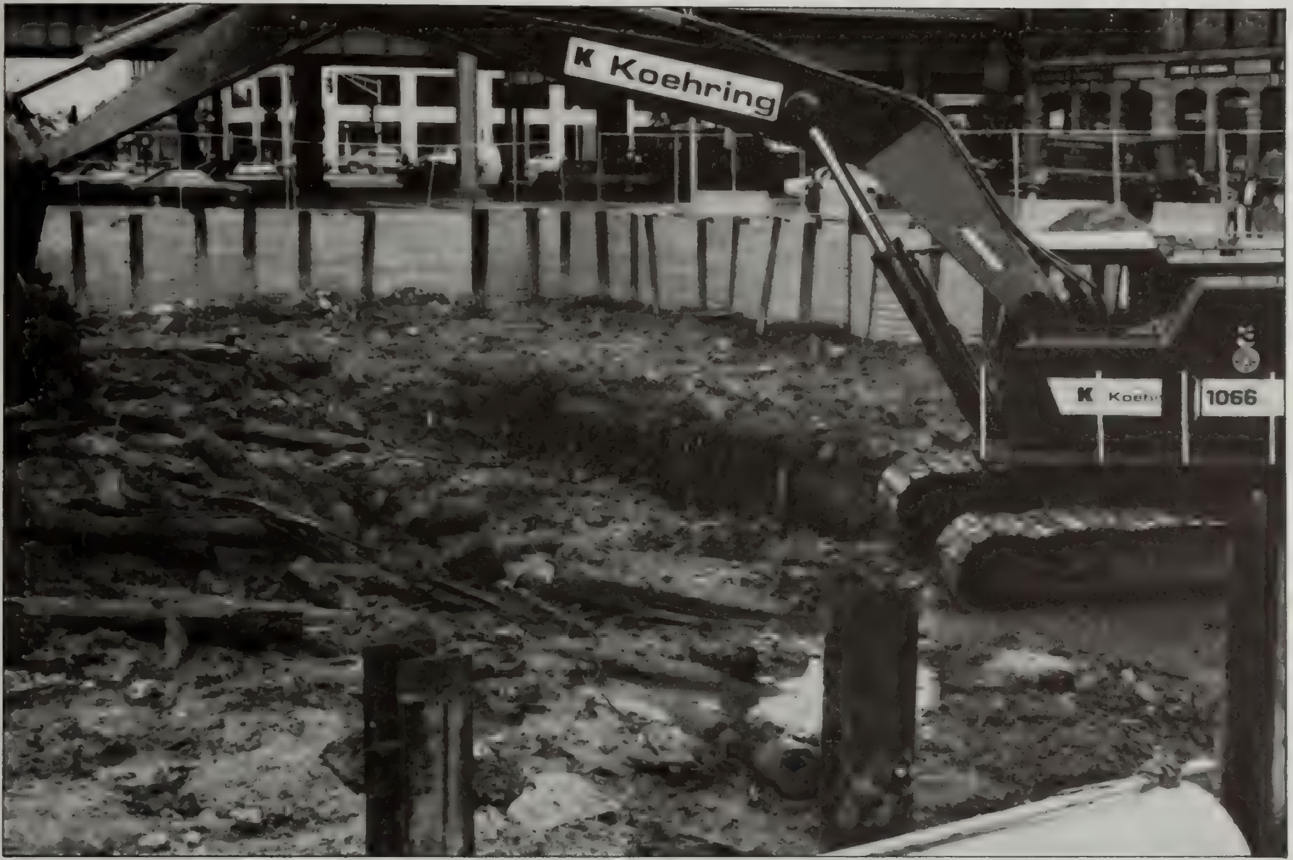
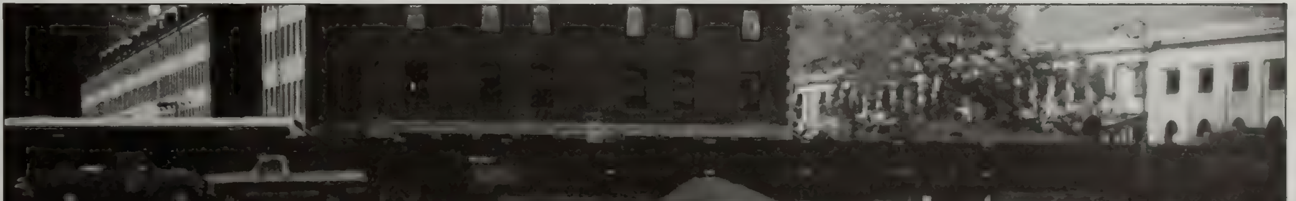
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Not to Scale



General View Looking Northeast



General View Looking West

FIGURE

4.10

Excavation Of Historic Fill At 200 State Street

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
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Table 4.5

ESTIMATED COMPOSITION OF FILL MATERIALS

Material	Estimated Percent Distribution
Wood	7
Coal	8
Cinders	19
Brick (including firebrick)	8
Ceramic	3
Concrete	5
Glass	3
Asphalt	3
Leather	3
Sand and Silt	41
Total	100

Source: Bechtel/Parsons Brinckerhoff

Similar floatability tests were performed on miscellaneous granular fill. Although less than 0.1 percent of this material floated, the surface of the water was covered in scum and bubbles which persisted for several days. In the cases of coal and cinders, the water surface was also scummy and in all the tests, including the wood, an oily sheen developed on the surface of the water.

Beneath the fill layer are extensive deposits of Boston blue clay and glacial till. The glacial till was deposited during the glacial age, while the Boston blue clay was deposited subsequently during the glacial retreat period. The clay is an outwash from the glacier.

4.2.4(d) Separability Of Excavated Soil/Practicability Considerations

During the excavation process, substantial mixing of material from the different geological strata is unavoidable because of the construction methods. The excavation support systems will consist primarily of struts that extend across the excavation to support the exterior walls. The use of these struts will dictate a method of excavation that will cause more mixing of the soil strata than would occur if a tieback system were used to support the sidewalls. Unfortunately, a tieback system will not be possible for most excavations because of the character of soil strata and/or the close proximity of adjacent properties.

Initial Excavation. The first 10 to 15 feet of excavation will typically be performed with backhoes loading directly into dump trucks. As a result of space limitations at most locations, it will not be possible to position two trucks where the backhoes will be working. Therefore, all material excavated from the top 10 to 15 feet of a typical excavation will be loaded into one truck at a time, causing any fill, organic, or clay material to be intermixed. In addition, there is no distinct line of demarcation between the fill and the organic material (they frequently look similar). Therefore, extensive mixing of fill and organic material is anticipated.

Deep Excavation. After the initial excavation is complete, the subsequent excavations will be performed primarily with track mounted loaders. These will be constrained by the struts that support the sidewalls of the excavation. The contract specifications will limit the allowable depth of excavation below the struts (usually to no more than 15 to 18 feet); this will prevent inward movement of the sidewalls. However, specifications may allow trapezoidal trenches so that equipment can travel beneath the middle portion of a strut.

In addition, the contractor will be forced to dig down to the bottom of any one portion of an excavation so that concrete work can be initiated as early as possible in the contract. These constraints will force the contractor to excavate on a sloping surface across several geologic strata, and this will cause extensive mixing of materials. However, it will be possible to separate the excavated material into two types at the time the trucks are loaded because of the unique characteristics of clay and fill that make separation feasible. Consequently, clay and till (which could be used to cap landfills) could be separated from all other materials as the excavation progresses. The workmen would separate the material into two piles and load alternate trucks with the different materials. Other types of fill do not readily lend themselves to separability at the site. In addition, limited truck loading areas, cost considerations, and other physical site constraints would make it impracticable to separate the materials into more than two categories.

4.2.4(e) Ongoing Characterization Program

While the characterization program detailed above has resulted in sufficient information to establish the overall chemical and physical characteristics of the excavated and dredged material to be generated by the Project, the Department has recognized the need for ongoing efforts to supplement and refine this information in order to support subsequent design and construction efforts and to obtain permits for the various disposal options under consideration. As part of the chemical characterization discussed in Section 4.2.4(a) and (b) above, areas were identified as needing further study in order to determine if releases of oil or hazardous materials had occurred. Suspect areas include sites of former gasoline stations, and current storage areas for petroleum products. In addition, the Project will require demolition of several buildings which could contain asbestos, petroleum storage tanks, or other facilities requiring specialized skills and techniques for their safe removal and disposal. The Department also has recognized a need for a continuing capability to respond to future emergency releases of oil or hazardous materials in or adjacent to Project construction areas which could contaminate soil to be excavated for the Project or threaten the health of workers or the public.

In order to address these concerns, the Department has engaged a consultant to:

- o assist the Department in complying with all relevant Massachusetts and federal environmental regulations;
- o provide services for the characterization, removal, and environmentally acceptable disposition of the excavated material, dredged soil, and native soils that result from project construction; and
- o provide effective emergency response capability for containment, control, and cleanup of unanticipated releases of oil or hazardous materials to the environment within the project right-of-way.

The Department's general approach for the assessment and remediation of the Central Artery/Tunnel right-of-way involves three primary activities: characterization, clearance, and disposal.

Characterization. Additional characterization will be performed on all parcels of land to be acquired for the Project whether such property will be excavated for roadway construction or not. The characterization process is divided into three tasks: Environmental Audits, Site Characterization (of contaminated areas), and General Material Characterization (of non-contaminated areas).

The Environmental Audit will establish the historic pattern of land use for a particular parcel of property, identify suspected contamination through a site reconnaissance, and confirm and delineate the extent of contaminated soils through a sampling and analysis program. The Audit will also identify hazardous material that remains contained (e.g., in buried storage tanks), but may pose a threat of future release to the environment during construction.

Where required, the Site Characterization will determine, through an intensive sampling and analysis program, the precise nature and extent of contaminated soils and groundwater within a parcel. This characterization will be guided by criteria to be developed in consultation with DEP. Such criteria will establish the levels (concentrations of target compounds) above which risk to human health or the environment is at issue. The results of the Site Characterization will be used to develop a soil remediation plan and/or to identify appropriate personal protection required for workers exposed to such soils. It is the Department's intent, where possible, to remediate these areas in advance of general Project construction activities in an area.

The General Material Characterization will define the characteristics and quantities of non-contaminated soils to be excavated during roadway construction. This characterization will be guided by criteria which are based on disposal regulations, industry practice, performance standards, and risk evaluations. General Material Characterization will be performed only on materials within the roadway excavation zone.

Clearance. Clearance, in the form of remediation, will be performed on those parcels where contaminated soils or groundwater are identified. Clearance options will vary depending on whether the contaminated material is within or outside of the roadway excavation zone.

Clearance will also be performed for hazardous materials that exist on a parcel and have not been released to the environment, but must be removed prior to excavation for roadway construction or parcel acquisition, such as asbestos insulation in buildings, underground petroleum storage tanks, etc.

Disposal. Disposal will be performed for all soils that are removed as a result of remediation (clearance) and those soils removed for the purpose of roadway construction. Disposal options will vary depending on whether the soil is contaminated, the degree of contamination, the type of soil excavated (e.g., urban fill, clay, dredge), and the ability to separate soil types during excavation.

In implementing this program, the Department, in consultation with DEP and other appropriate regulatory agencies, intends to develop a comprehensive set of procedures to guide the Department and its consultants and contractors in the conduct of assessment, characterization, design, and remediation or clearance and disposal work. These procedures in many cases will be evolutionary, and will be modified periodically to reflect changes in environmental, roadway design, and construction conditions. Among the procedures to be developed are the following:

- The General Characterization Procedure will describe the protocol for determining the presence and extent of soils in the right-of-way that pose a threat to human health and the environment. These protocols will be based on guidelines that quantify the levels of target chemical constituents that indicate the need for personal protection for workers on the Project or the need for remediation of soils prior to excavation for roadway construction.

  The procedure will also outline the protocol for characterizing soils in the excavation zone that do not pose a health and safety risk and do not require pre-roadway construction remediation. Guidelines will be presented to address the ultimate disposal options for such soils, and will provide the basis for preparation of plans and specifications for applying the various disposal options to given soil conditions.

- The General Clearance Procedure will describe the options and protocols for executing the remediation of contaminated soils and the clearance of non-released hazardous substances prior to general material excavation for construction of the roadway. These guidelines will provide a basis for preparing plans and specifications for remedial actions.

- The Sampling and Analysis Procedure will be a support document to the General Characterization Procedure, and will contain the standard operating procedures for the conduct of soil and groundwater data collection, and field and laboratory analysis. It will also provide guidance for the development of a site-specific sampling and analysis plan for use by the Department and its consultants.

- The Health and Safety Procedure will be a support document to both the General Characterization and General Clearance Procedures. It will outline the elements to be included in Health and Safety Plans developed by any contractors involved in environmental field activities associated with the CA/T Project. It will also provide a standard site-specific Health and Safety Plan form to be used by the Department in the conduct of field sampling and analysis, and remediation oversight.

- The Emergency Response Procedure will support and augment all field activities associated with the Project and address any environmental contingencies that may arise during design and construction of the roadway. The procedure will outline the steps to be taken upon discovery of and/or contact with contaminated and hazardous material that poses an imminent threat to human health or the environment, including notification of and coordination with state, federal and local response agencies.

- The Community Relations Procedure will support the General ROW Clearance Procedure, and outline the means by which the public will be informed of remediation activities associated with the Project.

Implementation of this comprehensive program will provide the data and procedures for designing and conducting the remediation and disposal options under consideration for use by the Project.

4.3 IDENTIFICATION OF POTENTIAL DISPOSAL SITES

The 13,154,000 cy of dredged and excavated material that will require disposal could be deposited at ocean, non-ocean marine, or inland sites. In order to determine the suitable and practical disposal options, a comprehensive site identification process was undertaken, yielding 851 candidate sites.

Three existing data bases were used as primary sources:

- Artery/Tunnel Project Disposal Site Screening Report (May 1989)
- Massachusetts Water Resources Authority (MWRA) Residuals Management Facilities Plan
- Massachusetts DEP lists of active and inactive landfills

In addition to these sources, a separate site search was performed using real estate brokers in the region. The purpose of this search was to identify any properties available for materials disposal which are not included in the other sources.

4.3.1 Artery/Tunnel Project Disposal Site Screening Report

A draft Disposal Site Screening Report which identified and evaluated potential sites for materials disposal was prepared in June 1988. Agency comments on that report were incorporated into a revised report issued in May 1989, while additional information on issues of practicability was developed and analyzed with conceptual design.

Sites in the 1988 draft were identified through: governmental agency personnel; a review of bathymetric and navigation charts; the MWRA (sites analyzed for MWRA residuals management); contacts with owners of large tracts of land, real estate developers, and contractors; and responses to a request for identification of additional sites published in the Massachusetts Central Register. Additional sites identified by the DEP were included in the revised report.

There were 27 sites identified as potential disposal locations (see Figure 4.11). The sites were located primarily in the Boston metropolitan region, but also included a site in Providence, Rhode Island, and ocean disposal locations as distant as off the coast of New Jersey. The 27 sites were classified into six categories to reflect drainage characteristics important for determining the types and qualities of materials which are suitable for each site (see Table 4.6).

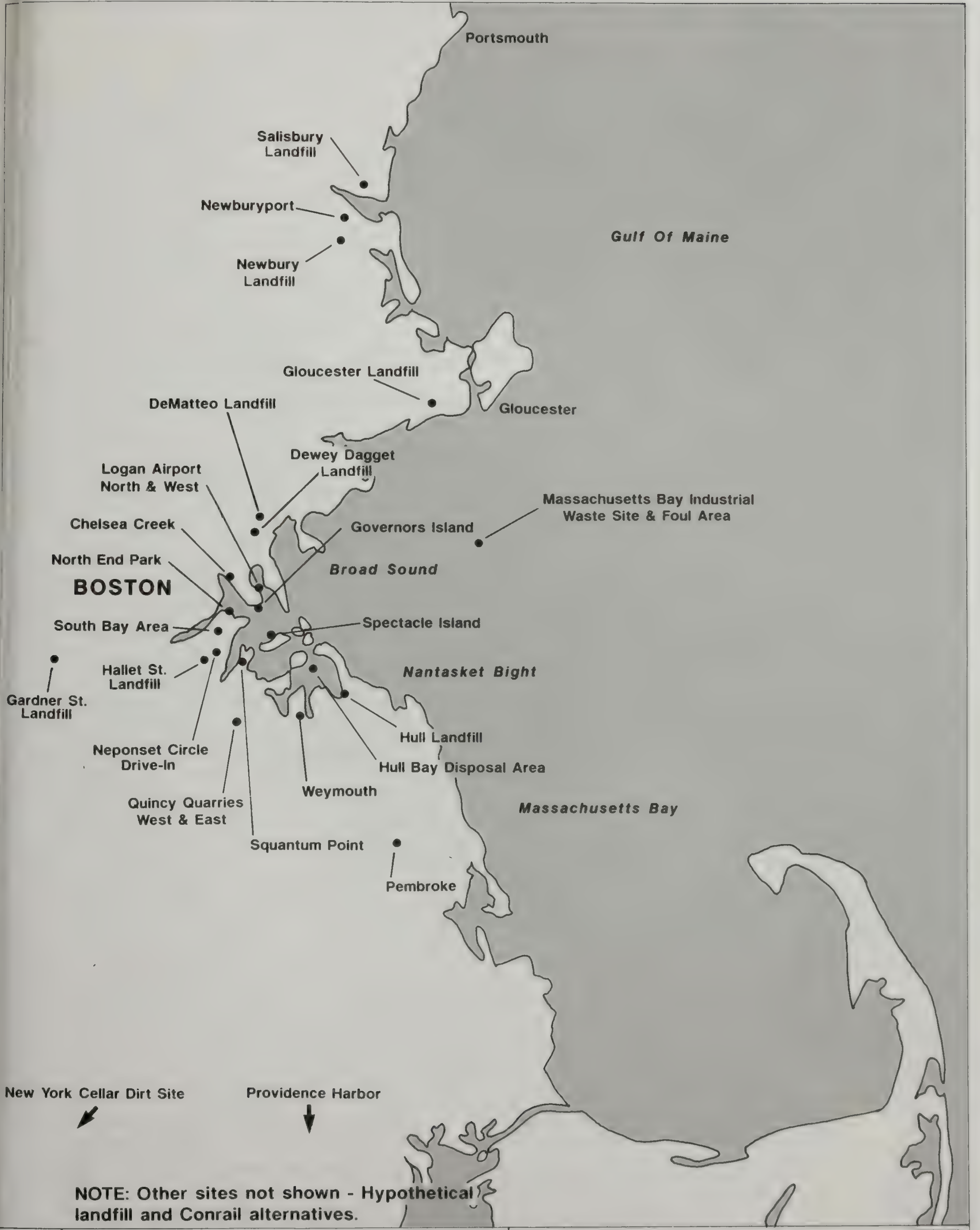
4.3.2 MWRA Residuals Management Facilities Plan

The MWRA has prepared a series of reports to identify and evaluate a large number of sites which could serve as locations for facilities needed to process, transport, and dispose of the residuals generated by treatment of municipal wastewater from the MWRA sewer service area. The MWRA study was used as a source for potential sites because it included a similar geographic area and a thorough evaluation a large number of MWRA sites.

The first step in the MWRA analysis was to identify a universe of sites which met the minimum criteria defined below:

- o Location - Within the MWRA service area (see Figure 4.12) except for a few coastal sites which are outside of that area.
- o Size - Eight acres for an inland site; five acres for a coastal site (coastal sites would be used only for transfer stations); 100 acres for a landfill site.
- o Development status - Sites with existing building development in active use were excluded.

An initial search process yielded a total of about 200 sites. An additional review was requested, and the number of candidate sites increased to 299 locations (Spectacle Island, Thompson Island and Quincy Quarry were also included in the list from the Disposal Site Screening Report, resulting in a net total of 296 MWRA sites). Additional sites were recommended by several sources:



NOTE: Other sites not shown - Hypothetical landfill and Conrail alternatives.

FIGURE 4.11

Disposal Site Screening Report Sites

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
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0 5.75 11.5 Miles

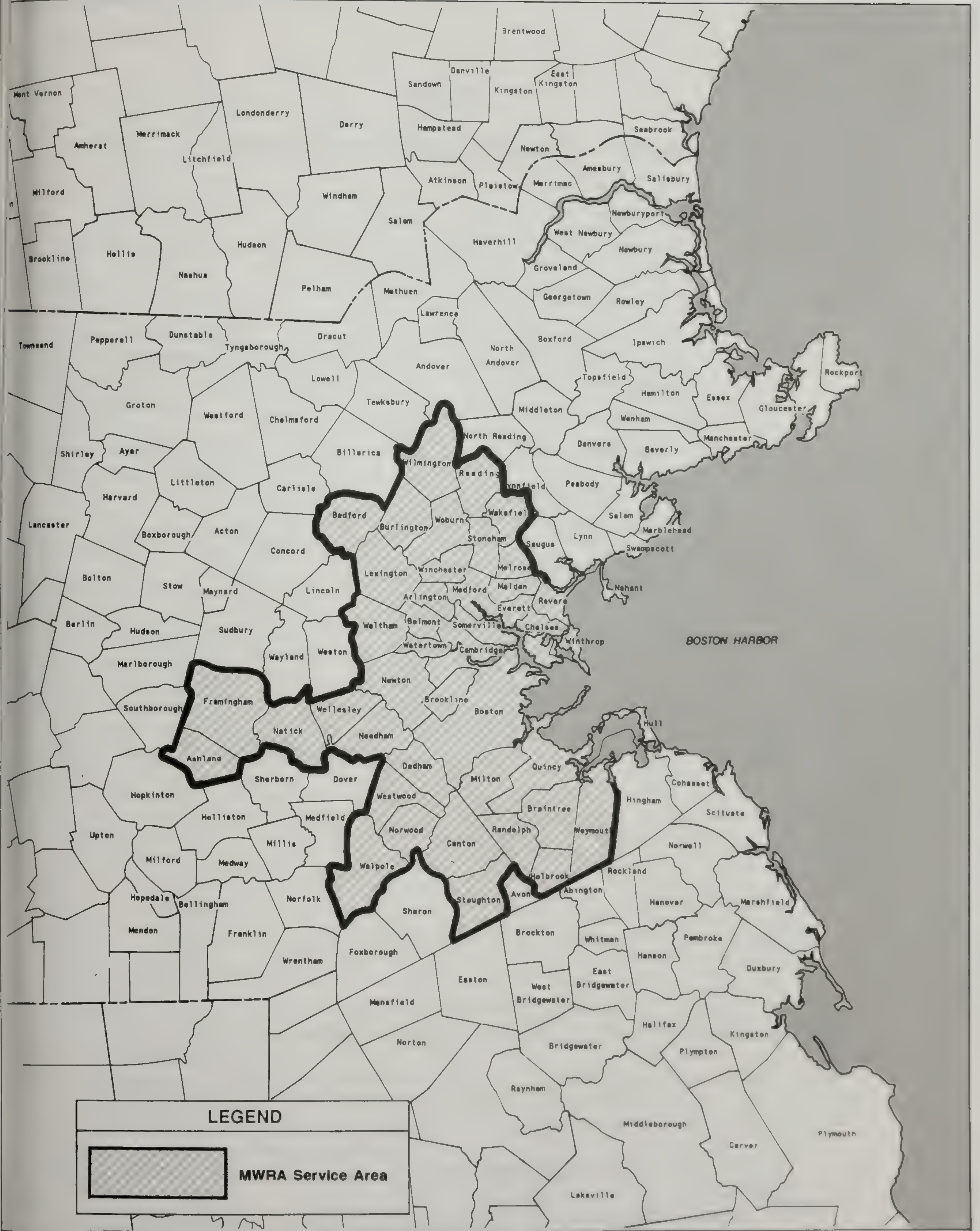


FIGURE 4.12 **MWRA Service Area**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 5 10 15 Miles

Table 4.6

DISPOSAL SITE SCREENING REPORT SITES

Inland[1]

Gardner Street Landfill
Gloucester Landfill
Newburyport
Newbury Landfill
Pembroke
Quincy Quarries East
Quincy Quarry West

Coastal[2]

DeMatteo Landfill
Dewey Daggett Landfill
Hallett Street Landfill
Neponset Circle Drive-In
Salisbury Municipal Landfill
South Bay Area
Squantum Point
Weymouth Municipal Landfill

Subaqueous[3]

Hull Bay
Logan Airport North
Logan Airport West

Confined Marine[4]

Chelsea Creek
Governors Island Flats
North End Park
Providence Harbor
Spectacle Island

Ocean[5]

Foul Area Disposal Site
Massachusetts Bay Industrial Waste Site
New York Cellar Dirt Site

Other[6]
Conrail

---

1. Inland: Drainage from site would enter a freshwater ecosystem
2. Coastal: Drainage from site would enter the marine environment without passing through a freshwater ecosystem
3. Subaqueous: Lands under coastal waters, where site is naturally or through human activity (e.g., dredging) deeper than surrounding bottom elevations
4. Confined Marine: Site located in a coastal environment, but whose contents would have to be confined to the site by structures
5. Ocean: Site in open water, without any containment structures

Source: Disposal Site Screening Report, Bechtel/Parsons Brinckerhoff, May 1989

- Public meetings
- Metropolitan Area Planning Council
- General Services Administration and Massachusetts Division of Capital Planning and operations
- MWRA On-Shore Water Transportation Facilities Assessment
- Tax assessor offices
- DEP list of potentially contaminated locations ("21E" sites)
- DEP files on active and closed landfills
- Field surveys

The result of this effort is an exhaustive list of undeveloped parcels of land within the MWRA service area. A list of these sites, by identification number, town, and size is contained in the Materials Disposal Appendix.

4.3.3 Massachusetts DEP

The DEP has identified 369 inactive and 163 active sanitary waste landfills throughout the State. (A list of the towns in which these landfills are located is contained in the Material Disposal Appendix.) Four of the inactive and four of the active landfills are already included in the lists from the Disposal Site Screening Report and the MWRA report, leaving a net total of 365 inactive and 159 active landfills.

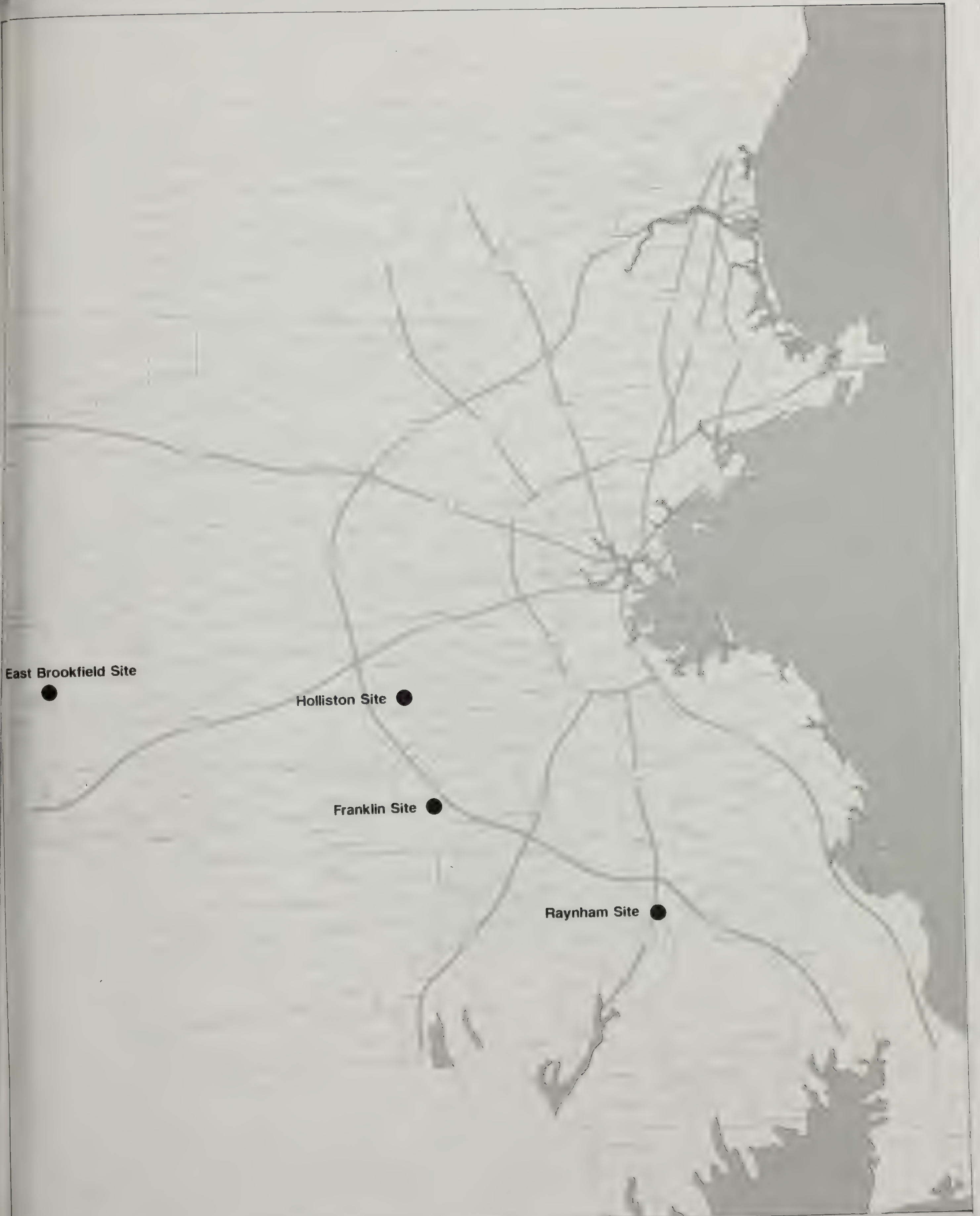
The capacities of these sites, and the types of material they can accept are major considerations for their use. The potential to expand existing landfills beyond current capacity will continue to be explored in coordination with DEP. Actions or plans for closing and capping these landfills would also have a major impact on their availability.

4.3.4 Additional Sites

As described, 847 potential disposal sites were identified throughout the state. Since these may not have represented the entire universe of available sites, an additional search effort was undertaken.

Realtors in the metropolitan area were contacted to determine if there were any land parcels available for sale which meet a few basic criteria (these realtors were not informed of the potential use of these parcels for materials disposal, to avoid any bias in the search). The key criteria used were that the sites should be large, undeveloped, and preferably zoned for industrial use.

Five sites were identified in this search, and one of these (Rowe Quarry in Malden/Revere) was already included in the MWRA list. Three of the other four sites are located in the same general area south of Boston, and the last site is about 65 miles to the west (north of Sturbridge). These four sites are shown in Figure 4.13 and are listed below:



FIGURE

4.13 Additional Sites

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93) TUNNEL (I-90) PROJECT
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o Raynham	Raynham Woods Commerce Center (330 acres), on Route 44, east of Route 24
o Holliston	Hopping Brook Business Park (280 acres), on Route 16
o Franklin	Franklin Industrial Park (225 acres), south of I-495
o East Brookfield	225-acre site on Route 49

Through consultation with the EPA, a potential site in New Bedford Harbor was identified. This site is polluted with PCB-contaminated soil, and one mitigation measure being considered by the EPA is capping the affected area with 2 feet of material. The Artery/Tunnel Project's dredged or excavated material might be a source of this capping material.

4.3.5 Summary Disposal Site Inventory

The site identification process described above yielded 851 potential disposal sites located throughout the State:

o Artery/Tunnel Project Disposal Site Screening Report	27 sites
o MWRA study	296 sites
o DEP list of inactive landfills	365 sites
o DEP list of active landfills	159 sites
o Additional search	4 sites
Total	**851 sites**

Included in this universe of initial sites are:

3 Ocean sites
9 Non-ocean marine sites
839 Inland sites

This inventory of sites provides a substantial universe from which to select practical and environmentally acceptable locations for the disposal of dredged and excavated materials from the Artery/Tunnel Project.

4.4 SITE SCREENING PROCESS

The evaluation of the more than 800 potential disposal sites was accomplished in a multi-step process whereby sites where first evaluated on the basis of practicability. Sites that were initially determined to be practicable were then assessed in detail for their practicability and environmental implications. This section includes a description of the general requirements for suitable sites, the ideal physical characteristics for a site, some of the qualitative issues associated with use of a site, and general disposal program planning considerations.

Sections 4.5 through 4.8 contain the results of the screening and evaluations of the sites which are able to accept different types of material. The dredged and excavated materials to be generated by the project have been divided into four categories:

- Acceptable clay and till
- Fill
- Unacceptable dredged material
- Acceptable dredged material

The characteristics of these material types have a considerable bearing on where they can be disposed. Therefore, a separate site evaluation was done for each of the four material types, using the same inventory of 851 sites.

The results of the site screening and evaluations were used to define the disposal options for the Artery/Tunnel Project's materials disposal program. These are described in Section 4.9.

4.4.1 Site Requirements And Screening Criteria

The type of material (dredged/excavated), the quality of that material, and the transportation modes used to haul the material away from the project area will all affect the selection of disposal sites to be used for the project. The inventory of 851 potential disposal locations were evaluated against minimum suitability criteria to determine which were practicable.

Site suitability requirements can be classified by physical attributes and program implemention considerations. The former refers to site size, location, access, etc. The latter refers to ownership, permits required, and the availability of a site consistent with the project's schedule.

The criteria used to screen the sites for practicability are identified in Table 4.7.

Site size was used because small sites would not provide an acceptable landfilling area and buffer zone. If the fill area is irregularly shaped, or if it has obstructions, an even greater area will be needed to dispose of a given volume of material.

Therefore, in the initial screening of the MWRA sites, parcels with total acreage of less than 80 net acres were eliminated from consideration (net acreage reflects the subtraction of unusable areas on the site, such as water bodies, steep slopes, etc.). These 80 acres provide an economic minimum size that would be needed for filling activities, and the remaining acres would be used as a buffer. However, non-ocean marine sites with less than 80 surface acres were not screened out on practicability grounds as this class of site (see Section 4.7) is essential for the disposal of unacceptable dredged material.

Depending upon the topography and geometrical shape of the area of the site available for the landfill, a total volume of approximately 4 million cy of material could be placed on a 80 acre site. This volume could be substantially reduced by such factors as ground shape and slope. Lining and capping of the landfill site would further decrease this volume.

Table 4.7

PRACTICABILITY SCREENING CRITERIA

1. Site dimensions or size. A minimum width of 740 feet is needed to provide for full height of landfill (50 feet) and equipment maneuverability. A size of 80 net acres is need to provide space for liner, leachate collection and treatment, buffer zones, and administrative space.	[Cost and Logistics]
2. Site is used as a park, conservation area, wildlife refuge or for a public purpose that would be precluded by disposal.	[Availability]
3. Site is used by rare plant or animal species. Use of the site would result in disruption of rare habitat, or mortality within rare species.	[Availability]
4. Site has already been developed or has otherwise been rendered unusable.	[Availability]
5. Existing sanitary landfill with limited disposal capacity reserved for municipal wastes, and/or to be closed within 10 years.	[Logistics, Technology]
6. Site is on Mass 21E or Federal superfund lists as a known hazardous waste site.	[Availability, Logistics]
7. Site did not meet minimum DEP landfill siting criteria.	[Availability, Logistics, Technology]
8. Use of the site would impede navigation.	[Logistics]
9. Cost is unreasonable.	[Cost]

Source: Bechtel/Parsons Brinckerhoff

The size of a landfill affects the cost of its operation. Efficient use of construction equipment, leachate collection and treatment, ancillary site works and erosion control measures can be achieved more economically with larger sites.

The size of the landfills used also affects the total number of sites necessary for disposal. For several reasons, the number of landfills used should be minimized. The impacts of landfills on the environment are numerous and the difficulty of controlling such impacts increases with an increase in the number of sites. At a minimum, it is probable that three or four inland sites would be required to provide the capacity needed for the disposal of fill material (7,272,000 cy) generated by the project.

Also, the complexities of the excavation contract administration become markedly more important when consideration is given to the already numerous excavation contractors (up to 25) hauling material to several sites. It is necessary to keep the number of sites to a minimum to ensure adequate monitoring and supervision of contractors.

Severe limitations on existing landfills, many of which are scheduled to close within the next ten years because of exhausted capacity or environmental contamination problems, constituted a screening criterion because the DEP has indicated that it is strongly opposed to using the very limited capacity available in the remaining landfills for disposal of materials other than sanitary waste. One goal of the DEP's Integrated Solid Waste Management Plan is to eliminate direct disposal of solid waste at all landfills by the year 2000. Preserving whatever capacity is still available at these landfills is a critical element in this plan.

The DEP has also noted that virtually all of the landfills in the Commonwealth are either municipally owned or private commercial facilities. The DEP has no legal authority to require municipal or private owners to accept material from the Artery/Tunnel Project. The DEP would also not consider "reopening" closed landfills for disposal of this material, especially since it has spent the last few years requiring owners to close and cap their landfills to correct environmental problems caused by those facilities.

Whether a site is listed on the Massachusetts 21E or federal superfund lists as a known hazardous waste site is listed as a screening criterion because any materials disposal on such a site would interfere with current or future remediation of the hazardous waste.

Whether or not a site meets the minimum DEP landfill siting criteria was considered because almost all of the inland sites would need a solid waste facility site assignment from the DEP before they could be used for disposal of excavated material.

4.4.1(a) Physical Requirements

The physical characteristics of a potential disposal site must correspond to the volume and quality of materials to be disposed there and to the transport modes used to carry material to the site. Sites to be served by barge must be in open water, on an island, or on a coastline. Sites to be reached by truck can be inland or coastal parcels.

The volume of material to be placed on a site is determined by the land area available for disposal activities. Design assumptions can be made about such physical requirements as height of fill and extent of buffer areas to calculate the area needed to accommodate a given volume of material. For example, 6 million cy of material piled to a maximum height of 50 feet, with a 100-foot buffer area around all sides, would cover approximately 175 acres of land. This land should be relatively flat and without obstructions such as power lines, roads, water bodies, etc. The site should also be as square as possible, since the capacity of a given parcel diminishes if the site is rectangular or unevenly shaped (because of slope requirements for filling).

In many cases, a site's drainage characteristics limit the type of materials which can be placed there. Sites which drain to fresh water, or which are underlain by aquifers, may not be able to accept material contaminated by chemicals or salt. The use of liners at such sites may help mitigate this problem, but such actions generally are considered undesirable because of cost and reliability concerns.

Other physical characteristics also may limit a site's practicable potential as a materials disposal location. Proximity of sensitive noise receptors (e.g., homes, schools, hospitals) may restrict disposal operations to a limited number of hours each day or require mitigation measures that are unreasonably costly. This is particularly important, since site access will be required 24 hours each day during peak excavation periods. Sensitive receptors along access routes to the site could impose similar limitations.

The presence of threatened or endangered species, historic/archaeological properties, or hazardous waste materials on a site could also make its use impracticable for reasons of cost, logistics, and technology. Other considerations pertaining to practicability with environmental implications are:

- o Adequate access routes for the specified transport mode (barge or truck)
- o No wetlands on or adjacent to the area which would be filled
- o Location an adequate distance from water supplies

4.4.1(b) **Program Implementation Issues.** In addition to the physical requirements for a disposal site, there are several other issues associated with the ability to implement disposal programs. These must also be considered in the site screening.

One of the most important factors is the availability of the site during the project's construction period. Materials excavation is expected to begin in 1991. Any sites which will become unavailable prior to that time, particularly because of development of the site, will therefore be unacceptable. Since project excavation will take place through 1998, it is also advantageous to use sites which are available for that entire period.

Another key issue is the ability to obtain necessary permits for use of a site. For example, sites where wetlands would be filled will require USACE and State permits. Inland sites which have not been approved for landfill activities will require DEP landfill assignment approvals. Other site characteristics may require additional permits. Each additional approval requirement has the potential for delaying, or negating, use of a site.

These program implementation issues have as much importance in evaluating potential sites as the physical characteristics of sites. While physical requirements can be strictly defined, these implementation issues are more difficult to assess, since their impacts are subject to regulatory, political, and public approval processes.

4.4.2 Disposal Program Planning Considerations

The development of the materials disposal program considered several key objectives. First, the number of sites to be used should be minimized for reasons of practicability. As the number of disposal sites increases, the cost and complexity of the disposal process increases. For example, a greater number and diversity of permit approvals would be needed for different sites with different conditions and site acquisition and preparation costs would increase. Additionally, excavation methods might need to be altered so that various types of material could be separated for disposal at different sites (this may be impossible, because of the lack of vacant areas for soil separation along the project's alignment.) Construction contracts might also have to be renegotiated if material from each excavation area were transported to multiple sites (this may result in higher costs.) All of these factors emphasize the need to use the fewest number of sites possible. Should numerous eligible sites be identified, it is evident that a smaller number of larger sites would be preferred.

In addition, the disposal program should minimize both short- and long-term impacts. Short-term impacts are those associated with moving material from excavation points to disposal sites. Typically, short-term construction period impacts range from 1 to 2 years. The Artery/Tunnel Project is unique in that the construction period will extend up to 7 years or more. Hence, in some cases "short-term" impacts could in fact extend for a substantial period of time. Long-term impacts are those experienced at the disposal sites and are a consequence of the altered landscape or the type or quality of the material itself. Therefore, an objective of the disposal program should be to use the most appropriate and least objectionable transport mode(s) to reduce short-term impacts and to use sites where long-term environmental impacts can be minimized or contained.

The above objectives were used to determine the proposed disposal options described in Sections 4.5, 4.6, 4.7 and 4.8 of this chapter.

4.5 BENEFICIAL USE OF NATIVE CLAY AND TILL

A large portion of the native materials to be excavated consists of Boston blue clay and glacial till. A separate site evaluation was conducted to determine how this clay and till could be disposed in an environmentally beneficial manner.

The fine-grained clay and till is highly impermeable and, therefore, could be used to provide a sealing layer around landfills. A composite liner is often required beneath solid waste landfills and a clay cap or synthetic membrane is required to complete the seal over the landfill. In both cases, project clay and till would be an excellent resource for this purpose. In addition, existing sanitary landfills which require capping could also benefit from the use of this project material. The communities in which the landfills are situated would benefit from the project supply of this valuable resource.

As indicated in Section 4.2, the native clay and till is located beneath the overlying fill material. During the excavation process, it will be necessary to excavate a portion of the fill before the native clay and till can be excavated. This constrains its use as a liner for the early portion of the fill, should an upland site be adopted. This is not the case at Spectacle Island, where the clay would be used primarily to cover the fill. Some of the clay and till would be excavated and mixed with the fill as a result of excavation techniques, thus reducing the amount of native clay that could be separated for capping and lining use.

In order to achieve overall project purposes, excavation of materials from the project will be 24 hours per day for much of the alignment. Consequently, it will be necessary to dispose of this material 24 hours per day or, if this is not possible, to have a temporary storage area for the material excavated at night.

One of the primary considerations in planning the disposal of clay and till is the salt content of the material. As previously discussed in Section 4.2.4, most of the clay and till to be excavated has high levels of sodium and chloride. These materials could leach into the ground at sites where clay and till are deposited and potentially cause fresh water contamination. The DEP has thus indicated that landfills located in coastal drainage areas would be preferred for the acceptable clay and till because any sodium/chloride leachates that may be produced would not affect fresh water.

However, further studies are being conducted to determine the potential impact from salt in clay and till at some coastal landfills that first drain to groundwater (that is not a fresh water supply) and then to marine waters. If the groundwater will not be affected by leachates from the clay and till, then these coastal (or inland) landfill sites could be considered suitable sites for using project materials for capping.

4.5.1 Volume

In Section 4.2.3, it was stated that about 4.6 million cy of excavated material is "native" clay and till. The "native" designation refers to the absence of contamination from chemicals and other types of materials. It was also estimated that about 75 percent, or 3.5 million cy, of this material could be excavated in such a way that it would not be mixed with other materials.

The recoverable native clay and till is distributed among the project construction areas as follows:

Third Harbor Tunnel	0
East Boston	630,000 cy
Charlestown and Cambridge	0
Charles River	0
Central Artery North	455,000 cy
Central Artery South	955,000 cy
I-93/I-90 Interchange	225,000 cy
Fort Point Channel	0
South Boston	1,205,000 cy
Total Clay and Till	**3,470,000 cy**

4.5.2 Transport Modes

All of the clay and till will be excavated from land areas. Therefore, it can be transported directly to a disposal site by truck or brought to barges for disposal at a marine site. Thus land and marine disposal sites were evaluated.

4.5.3 Disposal Sites

One objective in developing a disposal program for clay and till is to place the material in locations where it can provide a benefit. Therefore, sites investigated first were those that contain solid waste or other materials that must be capped.

The active and inactive landfills identified throughout the State by the Massachusetts DEP represent a set of 523 sites where acceptable clay and till might have beneficial use. The other sites included in the total inventory of sites made for this study do not include landfills, except for Spectacle Island which has an abandoned landfill.

The DEP's list of active landfills was reviewed to identify those landfills located in coastal communities. Table 4.8 identifies 27 landfills which meet this criterion, arranged by expected year of closure. Also shown is the total acreage of each landfill, and the estimated volume of capping material needed by each. This volume estimate assumes a 2-foot depth of clay over the entire site and is only an order-of-magnitude estimate.

The year-by-year capping material estimates indicate that from 1991 to 1998, when all of the project clay and till will be excavated, about 2.1 million cy of material will be needed to cap existing landfills. It is also possible that landfills closing earlier than 1991 may still need capping material (about 1.4 million cy would be needed to cap landfills scheduled to close in 1989 and 1990), or that landfills scheduled to close after 1998 could actually close ahead of schedule. It therefore appears possible that all 3.5 million cy of acceptable clay and till could be used as capping material at currently active coastal landfills. In addition to these active landfills, there is a comparable number of inactive landfills that require capping.

It is also estimated that about 2.4 million cy of acceptable clay and till from the project would be needed to adequately contain the other 8.3 million cy of material to be excavated by the project, if it is disposed at inland sites. The clay and till disposal program should therefore include use of 2.4 million cy at the disposal location(s) for project material, with the remainder to be brought to coastal landfills. It is assumed that suitable sites can be found for all of this material, and that a major public benefit will be generated by its use.

The clay and till could also be disposed at non-landfill, inland sites, or at marine sites. (The sites which might be used would be the same as those to be identified in a later section for potential disposal of fill and unacceptable clay and till materials.) However, disposal of the acceptable clay and till at non-landfill sites would have minimal public benefit and would require the disposal of higher volumes of material at other locations. Disposal at marine sites, unless the purpose would be to cover existing disposal sites, would not result in a beneficial use of material.

An important aspect of using clay and till for capping involves the identification of stockpile sites for materials excavated during the night. A site or sites would be necessary because excavation is scheduled for a round-the-clock basis. Landfill capping,

Table 4.8

ACTIVE COASTAL LANDFILLS

Town	Scheduled Year Of Closure	Acres	Required Capping Material Volume (cy)[1]
Cohasset	1989	9	29,000
Dartmouth	1989	115	367,000
Eastham	1989	55	176,000
Hull	1989	13	41,000
Plymouth	1989	16	51,000
Rowley	1989	18	57,000
Salisbury	1989	10	32,000
Sandwich	1989	14	45,000
Wellfleet	1989	8	26,000
Yarmouth	1989	125	399,000
Orleans	1990	20	64,000
Provincetown	1990	25	80,000
Truro	1990	16	51,000
Falmouth	1991	50	160,000
Fall River	1993	136	434,000
Hingham	1993	31	99,000
Fairhaven	1995	27	86,000
Barnstable	1996	64	204,000
Chatham	1996	50	160,000
Scituate	1996	57	182,000
Harwich	1996	150	479,000
Brewster	1998	32	102,000
Dennis	1998	70	224,000
Kingston	1999	20	64,000
Mattapoisett	1999	25	80,000
Bourne	2006	24	77,000
Marion	2010	95	303,000
Total			4,071,000

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1. Assumes 2-foot layer of capping material; calculated by Bechtel/Parsons Brinckerhoff

Sources: Massachusetts Department of Environmental Protection however, is not expected to be possible on a 24-hour basis. Therefore, capping materials would need to be stockpiled during periods when the landfills are not open. One such potential stockpile site is the inactive Hallet Street Landfill and adjacent (abandoned) Neponset Drive-In Theatre site in Dorchester (Boston). That site is scheduled for future park development by the Metropolitan District Commission and is readily accessible from the adjacent Southeast Expressway (I-93) without affecting any residential areas.

If this site were determined to be suitable for use as a temporary stockpile location, the Department would work with MDC to cap the site with project clay and use other project soil materials to shape the sites to enable their ultimate use as parkland.

4.5.3(a) Noise Impacts At Stockpile Sites

Because trucking to and from a stockpile site would occur at night, when landfills are closed, noise impacts from trucks on nearby sensitive receptors (i.e., residences) would have to be determined. For example, potential use of either the abandoned Neponset Drive-In Theatre site or the adjacent Hallet Street landfill site would have minimal impacts on residences on Hallet Street and nearby Hillside Avenue. These impacts are expected to be minimal since ambient noise from the Southeast Expressway, which divides the site from residences, would mask noise impacts from stockpile trucks as would the expressway embankment. Use of the Drive-In site, which is further away from residential areas than the Hallet Street Dump, may be a Section 4(f) impact, depending on the length of temporary occupancy for stockpiling. If feasible alternatives exist to using a Section 4(f) property, the alternative site must be used. These issues are examples of potential impacts that would have to be addressed before selection of a stockpile site for excavated materials can be made.

In conclusion, using acceptable clay and till for capping purposes at sanitary landfills would help mitigate public health hazards and would reserve capacity at other landfill sites for other types of material.

4.6 DISPOSAL OF ACCEPTABLE DREDGED MATERIAL

The two possibilities for disposal of dredged material are disposal at inland sites and disposal into a marine environment. Disposal at inland sites would be impracticable for several reasons. First, in order to be disposed of inland, the dredged material must be dewatered before it is spread on the site. Because no land is available at the project site for this purpose, the material would have to be transported wet, in sealed trucks, to the sites for dewatering. The transport of the water in the dredged material adds substantially to transport costs. Approximately 1,406,000 cy of this material will be dredged over a short period of time, and will therefore need to be processed at a rapid rate. Because of the volume of material and the rate of its disposal, there will not be adequate space at the inland sites to dewater the material quickly enough. Second, dewatering at inland sites poses special problems because the water is salty, meaning that normal dewatering methods cannot be used, as they may result in contamination of groundwater. Therefore, the only practicable disposal alternative is disposal into a marine environment.

4.6.1 Volume

In Section 4.2.3 of this chapter, it was noted that 1,406,000 cy of dredged material would be suitable for disposal at a designated ocean site. This finding was based on the results of bioassay/bioaccumulation tests which showed that this volume of material meets quality standards set for ocean disposal. Most of this material (1,266,000 cy) will be dredged for the Third Harbor Tunnel construction. The remaining 140,000 cy will be dredged for tunnel construction in Fort Point Channel.

The material to be dredged from the landside portions of the Third Harbor Tunnel is located within previously filled areas at Bird Island Flats and in South Boston and will require testing to determine suitability for ocean disposal. Similarly, that material dredged from the land bordering the Fort Point Channel is fill material and will require testing to determine suitability for ocean disposal. However, in this document it is assumed that this material will be unacceptable for ocean disposal.

4.6.2 Transport Modes

All dredged material will be placed directly on barges. The acceptable dredged material can then be taken directly from the dredging site to a marine disposal area.

4.6.3 Disposal Sites

There is one ocean site which has an interim designation for the acceptance of dredge materials: the Massachusetts Bay Disposal Site (MBDS) (previously referred to as the Foul Area Disposal Site). This site is located about 20 miles east of the Artery/Tunnel Project and is an area about 1 mile in diameter (see Figure 4.14). Ocean-going, bottom-dump barges would be used to transport and unload materials at this site.

The USACE has indicated that the 1,406,000 cy of dredged material, (201,000 cy of which would be dredged rock), which have satisfied bioassay/bioaccumulation testing criteria would be eligible for disposal at the MBDS. Actions have been initiated by the USEPA to obtain permanent designation for dredged material disposal for this site. Therefore, the site should be available throughout the project construction period.

Non-ocean marine sites were also considered as possible disposal locations for dredged material. Three non-ocean, subaqueous sites were identified as potential disposal sites (Hull Bay, Logan Airport North, Logan Airport West). These sites were not considered practicable or environmentally sound alternatives, however, because their use would have adverse environmental impacts as documented in Section 4.8.5, would require disruption of large areas of waters of the U.S., and would have substantial community impacts.

The two marine sites which would require dike construction to contain materials (Governors Island Flats, Spectacle Island) were also considered as potential disposal sites for acceptable dredged material. However, the addition of 1.4 million cy at these sites would result in the filling of more acres of waters of the United States because the containment structure would need to be expanded to accommodate the larger volume. The potential additional filling of shallow aquatic habitat areas near Governors Island Flats or Spectacle Island is a greater impact than the temporary impacts to the deep water ocean floor at the MBDS, which would naturally repopulate and revegetate after the disposal. Because disposal at the MBDS would have insignificant long-term impacts, ocean disposal is preferable.

Finally, the New Bedford Harbor Superfund site is another possible option for disposal of acceptable dredged material. The USEPA has indicated that this material may be useful for capping a large PCB-contaminated area and additional studies are being done on the subject. At this time it is not known whether this is a practicable or feasible option, but it will be evaluated further by the USEPA.

For the foregoing reasons, inland and non-ocean marine sites are impracticable for the disposal of acceptable dredged materials. Therefore, ocean disposal, and specifically use of the MBDS for this material is part of the Proposed Action.

4.7 DISPOSAL OF UNACCEPTABLE DREDGED MATERIAL

As previously discussed in Section 4.2.4, Material Quality, shallow sediments in Fort Point Channel and Charles River are contaminated with metals and hydrocarbons. The materials to be dredged in South and East Boston for the Immersed Tube Tunnel and in the Fort Point Channel area would have similar physical characteristics as the fill materials and would contain floatables. All the unacceptable dredged material would contain salt. These properties would severely restrict the disposal site selection.

The best alternative would be to transport the material by barge to a confined marine site. Unconfined sites would be precluded from use by the floatable properties of much of the material. The use of upland sites would not be practicable for the same reasons discussed in 4.6.1 above; namely, the impossibility of dewatering at the dredge sites, the fact that the material would need to be hauled wet, requiring specially sealed trucks, the difficulty of dewatering at the disposal sites given the rate and quantity, (over 1 million cy) of the disposal, and the difficulty of dealing with salty water at inland sites.

4.7.1 Volume

In Section 4.2.4(b), it was noted that up to 1,010,000 cy, of a total dredged volume of 2,416,000 cy, would be unsuitable for disposal at a designated ocean site and is therefore considered "unacceptable" material. The total dredged volume includes a volume of approximately 925,000 cy which would be dredged from the ends of the tunnel crossings of Boston Harbor and Fort Point Channel. Because this material is predominantly historic fill, it is assumed at this time that it will not meet standards set for ocean disposal when it is sampled and tested.

4.7.2 Transport Modes

All dredged material will be placed directly on barges. The unacceptable dredged material can then be taken directly from the dredging site to a marine disposal area.

4.7.3 Disposal Sites

Non-ocean marine sites were considered as possible disposal locations for dredged materials. Three non-ocean, subaqueous sites were identified as potential disposal sites in the previous section (Hull Bay, Logan Airport North and Logan Airport West). These sites were not considered practicable or environmentally sound alternatives however, because their

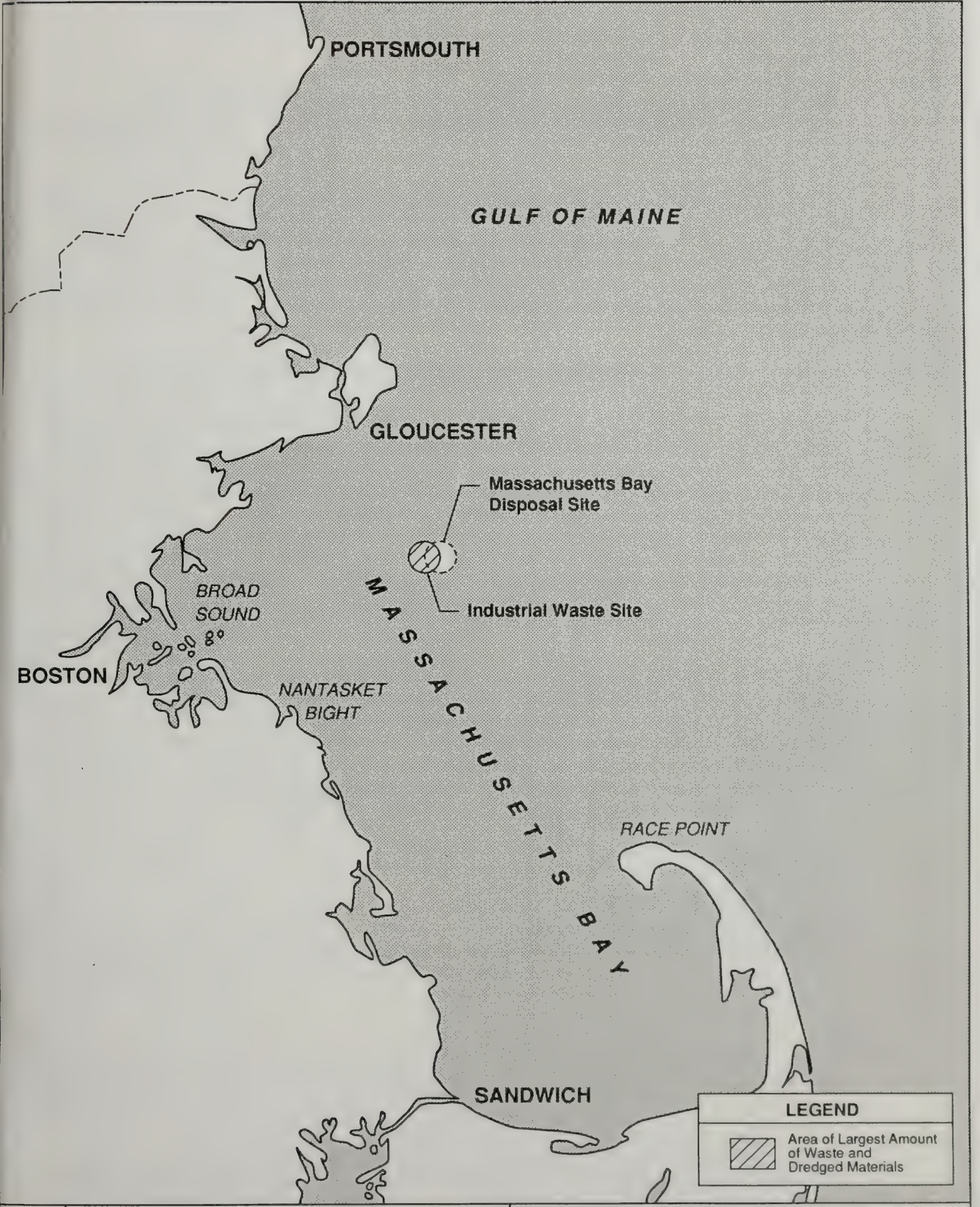

FIGURE 4.14 **Massachusetts Bay Disposal Sites**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 5 10 Nautical Miles

use would have adverse environmental impacts. Sediments would be transported towards beaches, and floatable materials would form rafts that would move about the surface of the water and be deposited on beaches.

The two marine sites would require dike construction to contain the materials (Governors Island Flats and Spectacle Island) are also potential disposal sites. The 1,010,000 cy of material could be disposed at Spectacle Island, although dewatering would be required as part of the disposal procedure, so that sufficient strength could be developed in the material to allow construction of stable slopes. The use of Governors Island Flats would be less desirable because the commercial shellfish harvesting area would be adversely impacted.

4.8 DISPOSAL OF FILL AND UNSORTED CLAY AND TILL

The following important factors need to be considered in the evaluation of potential disposal sites for the fill material and unsorted clay and till. The volume, over 7 million cubic yards, when added to the volume of other types of material, will require disposal at a rate of about 15,000 cy (or 1,200 truck loads) per day for a 3-month period during the peak year to meet overall project purposes; this would add to the already congested traffic in the vicinity of the project alignment. Trucking the material out of the City would further strain already overloaded highways. Material will be excavated 24 hours per day for much of the project alignment and for approximately 7 years. At the project site, there is a lack of space available for stockpiling materials, and thus disposal sites which can be used 24 hours per day are necessary.

The physical and chemical characteristics of the material (i.e., salt content, contamination with low levels of metals and hydrocarbons, and a content of floatable materials) would require a contained disposal site. Upland sites would require lining and capping. Contained marine sites would require capping and a leachate control system. This material contains pieces of brick, concrete, wood, and other miscellaneous debris, which would be too big to permit its use as daily landfill cover. It also contains organic material and plastic clays, making it unsuitable as backfill around the various project structures.

4.8.1 Volume

A total of 13,533,000 cy of material will be dredged or excavated for the Artery/Tunnel Project. Previous sections have described the evaluation process for 6,261,000 cy of project soil. This section describes the results of an evaluation process for the remaining 7,272,000 cy of fill and unsorted clay and till not suitable for capping.

4.8.2 Transport Modes

Fill requiring disposal would be excavated from the entire construction alignment, as described in Section 4.2.2. Fill could be transported by barge and/or truck depending on the origin area.

Included in the total 7,272,000 cy of material is 1,654,000 cy of material from East Boston and Charlestown/Cambridge. This material should only be trucked north, since it is impracticable to route trucks south from those construction areas. The implication of this procedure is that, with an inland disposal option, 1,654,000 cy would always go to a site or sites north of the project area. All of the material from the other construction areas could also be taken north, so the volume of material that could be trucked north would range between 1,654,000 cy and 7,272,000 cy. The volumes to be trucked to sites south of the project area could range from 0 cy (all material trucked north) to 5,618,000 cy (all but East Boston and Charlestown/Cambridge material trucked south). This indicates that with the exception of 84,000 cy from Charlestown and Cambridge, all fill materials could be barged to one or more marine sites.

4.8.3 Disposal Sites

4.8.3(a) Ocean Disposal

Existing Conditions. One option for the disposal of the 7,272,000 cy of excavated material is the ocean. It is assumed that any ocean disposal site would have sufficient capacity for the project generated materials. However, there is no site in the United States now designated to accept excavated material. The closest potential site known to possess the requisite site characteristics for this disposal is the MBDS. However, this site has interim designation for the disposal of dredged material only. Therefore, this site, or another ocean site, would have to receive a specific designation for excavated material before such material could be disposed there.

The MBDS is located in the Stellwagon Basin of Massachusetts Bay where the water depth is approximately 160 to 300 feet. The center of the site is approximately 16 miles from Marblehead, 25 miles from Boston and 30 miles from the Cape Cod peninsula. Information presented below on the MBDS has been obtained from the EPA's draft environmental impact report for permanent designation of the MBDS.

Tidal waters are the only resource area that occur at this site. The Disposal Site substrate is composed of three general areas. The western third is the area which has been the focus of dumping of dredged materials. Along the northeast quadrant is an area of relatively coarse materials such as sand and cobbles. Between these two major areas is a band of natural silt and clay. The northeast and northwest areas of the site contain shoals that rise to a depth of 190 feet. The remaining site is relatively flat and featureless. There is little evidence of substantial changes in topography as a result of prior disposal.

Sediments within the dredged material area contained statistically significant elevations in concentrations of chromium, copper, lead, zinc, oil and grease, petroleum hydrocarbons, and PCBs compared to the mud reference station. Levels of arsenic, mercury, nickel, and cadmium were not significantly greater in the disposal site samples. Based on the Massachusetts Criteria For Classification of Dredge or Fill Material, the dredged sediments are classified as moderately contaminated because concentrations of arsenic, chromium, lead, and zinc fall into the Category II range.

Turbidity data measured at the site during 1973 and 1974 indicate a range in values from 0.1 to 11.2 mg silica/liter. The average value for 70 measurements was 1.912 mg silica/liter. During a 1974 disposal operation, values of 1.1 mg (200 feet) to 19.3 mg(100 feet) silica/liter were measured.

Salinity in surface water layers is subject to variation of several parts per thousand (ppt), ranging from 31 to 33 ppt, while the bottom waters were more stable at 32 ppt. Temperature varies with depth. During the summer, the water column is strongly stratified with the thermocline at approximately the 50 foot depth. Surface waters in the summer may approach temperatures of 17 to 18°C with the bottom at approximately 5°C. During the winter, the water column is isothermal at approximately 5°C.

The water quality of the site has been examined by several experts, most recently by the Science Applications International Corporation under contract to the U.S. Army Corps of Engineers (SAIC and HMM, 1987). The results of the SAIC study agree with earlier work by Gilbert (1975) and others.

The water column at the site is well oxygenated: oxygen concentrations of 7.8 to 12.3 mg/l were measured. The mean oxygen level for all depths was 9.5 mg/l with a standard deviation of 1.45 mg/l. Saturation levels ranged from 79 to 140 percent. Measurements of pH averaged 7.81 with a range of 7.4 to 8.0. Macro-nutrient concentrations at the MBDS are low. Ammonia averaged 0.28 mg/l, nitrate averaged 0.134 mg/l and total phosphorus levels averaged 0.035 mg/l. Metal concentrations in the water column were below chronic and acute criteria for marine waters with the exception of mercury. On January 1986, a water column mean of 2.43 ppb was measured which is above both the acute criteria of 2.1 ppb, and the chronic criteria of 0.025 ppb [U.S. Army Corps of Engineers (USACE), July 1988]. The remainder of samples were below detection limits. If mercury samples collected in January 1986 measured below detection limits, the water column mean would be 1.35 ppb with a standard deviation of 0.82 ppb. This computation is somewhat suspect, however, as the method detection limit is well above the chronic criteria concentration.

The site evaluation studies of the MBDS prepared by the USACE (July 1988) indicate that tidal currents at the site are characterized by mean velocities near the surface of 15 to 20 cm/sec (0.5 to 0.67 feet per sec) in a NNE-SSW orientation. In the Massachusetts Bay, water circulation is generally counterclockwise and, in the immediate vicinity of the MBDS, the long-term currents would be expected generally in a southerly direction. Drifters released near the crest of Stellwagon bank were recovered along the eastern shore of Cape Cod, while those released on the western margin of the bank were recovered in Cape Cod Bay (Schlee *et al.* 1973). In all cases drift velocities were very low, ranging from 2 to 10 cm/sec (0.07 to 0.33 feet per sec).

Although northwesterly and southwesterly winds prevail, it should be noted that for approximately 47 percent of the year, winds are blowing towards the shore, and the strong winter gales are predominantly from the northeast.

Marine resources at the MBDS vary with substrate condition. That portion of MBDS upon which dumping has not taken place (natural silt clay bottom) is dominated by a polychaete worm community with *Levinsenia gracilis* being most common. Other common members of the benthic community included rhynchocoel worms, oligochaete worms and a clam *Thyasira flexuosa*. This area has less diversity than the area that has received dredged materials.

In the area of the Disposal Site where dredged material was deposited, a diverse community dominated by the polychaete worm *Spio pettibonae* is found. However, a number of other subdominant species of worms including *Chaetozone setosa* and *Mediomastus ambiseta*, as well as other fauna are present. Because dredged materials were disposed at the Industrial Waste Site as well, in the absence of site specific data, it can be inferred that the benthic community is similar to that of the area where dredged materials were deposited within the Disposal Site.

The third, and most diverse community was found in the sand and cobble bottom region. Again, polychaete worms (*Exogone verugera profunda*, *L. gracilis*, and *Prionospio steenstrupi*) were the dominant form.

Over 40 species of finfish are known to occur at the Disposal Site. Trawler samples collected by the Massachusetts Department of Marine Fisheries (MDMF) and the National Marine Fisheries Services (NMFS) found the majority of these species. The mailed sculpin was rarely observed. Commercial fishing on either the Industrial Waste Site or the MBDS is not common because of the large number of obstructions. However, commercial fishing in unobstructed areas in and around the disposal sites does occur. The dominant species caught there was the American place, which comprised 66 percent of the catches by number and 45 percent of the catches by weight. Winter flounder, witch flounder, Atlantic cod, and ocean pout were the other dominant species. The average annual catch in an area 10 minutes of arc (nautical miles) by 10 minutes of arc centered on the MBDS was reported at 6.3 million kilograms of fish (U.S. Army Corps of Engineers, July 1988).

There is known lobster harvesting activity in the area of the site. In addition sea scallops, rock, Jonah and red crabs, northern shrimp, short fin squid, long fin squid, and ocean quahogs occur there.

Marine mammals observed at the site include harbor, white sided and white beaked porpoises, gray and harbor seals, Atlantic pilot whales, minke whales, and grampuses. The leatherback turtle may transit the site. Birds may also feed in the area. Abundance of these wildlife species is limited by a lack of habitat diversity.

Threatened and endangered species known to forage at the disposal sites include the finback whale, sei whale, humpback whale, and the northern right whale. The area may be traveled by the endangered Atlantic Kemps Ridley turtle and threatened loggerhead turtle, although the Bay is considered marginal habitat for these species.

The northern right whale is the world's most endangered large whale. There are approximately 600 individuals remaining with about 350 in the Western North Atlantic. During March to May, most sightings are in the Cape Cod/Massachusetts Bay Area. Feeding activity is the most frequently seen behavior at this time. Most feeding occurs below the surface of the water. However, surface feeding activity has been observed in Cape Cod Bay.

Ocean Disposal Regulations. The practicability of ocean disposal relates to the ability to acquire the necessary designation of the disposal site. In order to evaluate practicability, it is therefore necessary to review the regulations applicable to floating materials discharged at sea with respect to the impacts that would be anticipated from ocean disposal.

The Ocean Dumping Regulations under Section 102 of the Marine Protection Research and Sanctuaries Act (MPRSA) are published at 40 CFR 220 through 227. According to

Section 220.2(d) these regulations apply to material of any kind or description including, but not limited to, incinerator residues, wrecked or discarded equipment, rock, sand, excavation debris, and municipal, industrial, or other wastes.

According to Section 227.5, "The ocean dumping of the following materials will not be approved by USEPA or USACE under any circumstances: (d) persistent inert synthetic or natural materials which may float or remain in suspension in the ocean in such a manner that they may interfere materially with fishing, navigation or other legitimate uses of the ocean."

Paragraph 227.9 specifies that materials that may damage the ocean environment due to the quantities in which they are dumped may be dumped only when the quantities are controlled to prevent long-term damage to the environment or to amenities.

Section 227.10 specifies that waste which may present a hazard to shorelines or beaches may be dumped only at sites and under conditions that will assure no unacceptable danger to shorelines or beaches.

Section 227.12(b) specifies that materials which may float may be dumped in the ocean only when they have been processed in such a fashion that they will sink to the bottom and remain in place.

Subpart D regulates impact of the proposed dumping on aesthetic, recreational, and economic values. Paragraph 227.17(a)(1) specifies that the potential for affecting recreational uses and values for ocean water, beaches, and shorelines must be evaluated. The potential for affecting recreational value of living marine resources must also be considered.

Section 227.18(d) specifies that visible characteristics of material (i.e., suspended particulates) which result in an unacceptable aesthetic nuisance in recreational areas must be considered.

Under Subpart E impacts of the proposed dumping on other uses of the ocean must be evaluated. Subpart E is intended to evaluate potential impacts on specific uses of the ocean, rather than impacts on overall aesthetic, recreational, and economic values as discussed previously. The uses considered shall include but not be limited to recreational fishing in open ocean, coastal and estuarine areas, recreational use of shorelines and beaches, recreational navigation, and actual and anticipated exploitation of living marine resources.

The ocean discharge of floating materials is clearly prohibited by paragraph 227.5(d). The other provisions discussed above provide amplification and detail related to the provisions of 227.5. Although no specific criteria or implementation guidance exist for Section 227.5, the provisions are so clear and comprehensive that little guidance has been considered necessary. The most comparable precedent for the proposed operation relates to the Cellar Dirt Site off New York City. According to USEPA Region II in New York City, there are presently no permits for use of the Cellar Dirt Site, and EPA Region II is planning to rescind designation of the site. EPA Region II uses the ocean dumping regulations (40 CRF 220-228) as a basis for regulating use of the Cellar Dirt Site. It is EPA Region II's policy that floatables, no matter what size, are restricted from ocean disposal in accordance with the regulations.

The Section 227.5 prohibition on the disposal of floating material is comprehensive and unequivocal. The language essentially repeats a comparable prohibition contained in the London Dumping Convention to which the United States is signatory. Therefore, disposal of floating materials at sea would violate not only US law but also international treaty.

In Section 4.2.4, it was estimated that a large volume of wood, coal, and cinders would float if excavated material is disposed in water. Based on tidal currents and wind speeds at the MBDS, a substantial percentage of this flotsam would travel in a shoreward direction. At velocities ranging from 0.07 to 0.67 ft/sec it would take between 1.5 and 14 days to arrive at Marblehead (16 miles distance), between 2 and 22 days to arrive at Boston (25 miles distance), and between 3 and 28 days to arrive on Cape Cod peninsula (30 miles distance).

Accumulations of material that would arrive on the various beaches in Massachusetts Bay would have considerable adverse impacts on the environment in the immediate vicinity of the disposal site, as the material disperses in the Bay, and as it accumulates on the beaches. In the draft report, Potential For Fill Material To Float April 1990 by Bechtel/Parsons Brinckerhoff, it is indicated that based on a model using wind as the driving force, up to 295 cy per mile would build up on beaches over the life of the project.

In addition to violating the prohibition of Section 227.5, the discharge of floatable materials from the Artery/Tunnel Project would also conflict with several other provisions of the regulations. Serious questions would be raised about compliance with the limitations on quantities to be disposed under Section 227.9. The discharge of the proposed volume of material over the proposed lengths of time would be difficult to reconcile with the requirement that discharges which may seriously reduce amenities may be dumped only when the quantities dumped at a single time and place are controlled to prevent long-term damage. The daily discharge of material with floating components over a period of several years would be difficult to reconcile with the requirements of 227.10 that wastes which may be a hazard to shoreline or beaches may be dumped only under sites and conditions that will insure no unacceptable danger to shorelines or beaches.

Given the wind and surface current directions in Massachusetts Bay, it is reasonable to expect floating materials to move onto beaches and shorelines north and south of Boston. This would present an aesthetic impact both offshore and as the material accumulated on recreational beaches. Section 227.10 specifies that the evaluation of impact will consider the potential for affecting recreational and commercial value of ocean water, inshore water, beaches, and shorelines. This clearly is incompatible with the continuous movement of floating materials onto the shore.

Section 227.10(a)(2) also requires that consideration be given to the potential for affecting recreational and commercial values of living marine resources. Whale watching as a commercial and recreational activity off Boston is important. The aesthetic impact of floating materials would adversely influence the recreational satisfaction of whale watching, and thereby would have an impact on the commercial success of whale watching cruises.

While the floating material may not directly interfere with recreational fishing activity, the desirability of fishing in waters containing floating material is lessened and the enjoyment of recreational fishing would be detrimentally affected by the continued presence of floating material on the water. The water area off Boston is used extensively for recreational fishing.

Sailing is also a popular activity that derives a large measure of its satisfaction from acceptable waters. This satisfaction would be impaired by long-term presence of floating material on the water surface. Section 227.18 specifies that one of the factors considered in making an assessment of the potential for impact is visible characteristics of the material (e.g., suspended particulates) which result in an unacceptable aesthetic nuisance in recreational areas. Section 227.21 lists specific uses of the ocean that must be considered in evaluating the potential for impact. Among those uses are recreational fishing in ocean, coastal, and estuarine areas, recreational navigation, commercial navigation, recreational uses of shorelines and beaches, and exploitation of living marine resources, all of which have been discussed above and all of which are potentially impacted by disposal of materials containing floatables.

Disposal Operations. Consideration has been given to removing, at the barge loading facilities, all material that would float. This would require dumping the material into a flooded dump trough then skimming off the surface (floatables) prior to loading the material onto barges. This scheme has been rejected for the following reasons:

- o There is no feasible technology to control the loss of saturated material into the environment.
- o This would not remove all floatables because the water column through which the material would settle could not be greater than 15 feet deep as opposed to the 300 foot depth in the MBDS.
- o The added time required to perform this operation would either cause a serious schedule delay or would necessitate having to greatly increase the size of the dump trough. Unfortunately, there is not sufficient space to greatly increase the size of the dump trough.

Consideration has been given to binding the mass together with either asphalt emulsions or portland cement. If this were possible, it would eliminate the floatability problem because the entire mass of material would be bound together and the floatables would sink along with heavy material. This scheme has been rejected for the following reasons:

- o It would be inefficient because the material would have to be processed through a pug mill where it would be mixed with either the asphalt emulsion or portland cement. After mixing, the material would have to be compacted into blocks. These blocks would have to "cure" for a few days prior to dumping in the ocean.
- o The space requirements for this operation would not be available at any of the barge loading facilities.

Consideration has been given to containing and retrieving the floatables at the dump site. This would require booms to contain the material on the surface and "skimmers" to retrieve it. This scheme has been rejected for the following reasons:

- o The ocean waves would wash the floating material either over or under the boom whenever there is a substantial wind.

- o The boomed area would have to be enormous to capture all the material that sinks with the mass when originally dumped but later floats to the surface. The currents could carry this material a long distance from the original dump point prior to its returning to the ocean surface.

- o The boom anchorage system and the boom itself would impact upon fishing and aquatic habitat including the right whales.

Therefore, after taking into consideration the physical characteristics of the fill material, the environmental impacts associated with this type of material on the marine life, the ocean currents in Massachusetts Bay and the Gulf of Maine, and the statements of policy expressed in the Ocean Dumping Act (MPRSA) and its implementing regulations, the Department has taken the position that ocean dumping of project excavated materials would cause unacceptable adverse environmental impacts and further evaluation of this option would not be in the public interest.

4.8.3(b) Non-Ocean Disposal Sites

As an alternative to the use of an ocean site, the 7,272,000 cy of fill and unacceptable till and clay material could be disposed at a combination of non-ocean marine sites or inland sites. In Section 4.4.1 above, 848 non-ocean marine or inland sites were identified as possible locations for disposal activities.

The 848 potential sites have been screened for suitability in several steps described in the following section of the chapter. The initial screening eliminates those sites which would not be available for use as a disposal site for practicability or "fatal flaw" reasons. A second screening level evaluates sites based on additional criteria relating to physical, accessibility, environmental, socioeconomic, and cultural characteristics.

The first stage screening process was designed to refine the list of potential disposal sites to include only those sites which appear to be practicable. The second level screening identified the environmental impacts associated with those sites. These impacts are described in Section 4.8.4.

Criteria used in the initial practicability screen are identified in Table 4.8.

Initial Site Screening. Results of the initial site screening are summarized in Table 4.9. The five non-ocean marine sites identified in the Artery/Tunnel Project Disposal Site Screening Report will be evaluated in further detail later:

- o Hull Bay
- o Logan Airport North
- o Logan Airport West
- o Governors Island Flats
- o Spectacle Island

All of the 296 sites in the MWRA list are either inland or non-ocean marine locations, with the exception of two which are Harbor Island locations. These sites include most

Table 4.9

DISPOSAL SITE SCREENING SUMMARY

	SITE				
	Artery/Tunnel Project Disposal Site Screening Report	MWRA Residual Management Facilities Plan	MA DEP Sanitary Landfills	Additional Sites Identified by Realtor	Total
Number of Sites Identified	27	296	524	4	851
Number of Non-Ocean Marine or Inland Site	24	296	524	4	848
Number of Sites That Fail Practicability Screening Criteria[1]					
1. Site size	1	234	0	0	235
2. Park, conservation area, wildlife refuge Other public purpose	0	20	0	0	20
3 Rare/endangered species	0	14	0	0	14
4 Previously developed or otherwise unusable	7	10	0	3	20
5. Reduction of landfill capacity	8	0	524	0	532
6. Massachusetts 21E/superfund	0	4	0	0	4
7. DEP landfill siting criteria	0	11	0	0	11
8. Navigation impediment	1	0	0	0	1
9. Unreasonable cost	2	0	0	0	2
Total Sites Failing Initial Screen	19	293	524	3	839
Total Sites Remaining	5	3	0	1	9

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[1] Numbers reflect sites which did not pass practicability criteria; sites that fail more than one criteria are only counted once

Source: Bechtel/Parsons Brinckerhoff

undeveloped parcels of land more than 5 acres in size within the MWRA service area. MWRA site boundaries were defined two ways so that capacities could be estimated with and without water resources in order to avoid filling of wetlands.

The 296 MWRA sites were screened based on 80 net acres, as discussed in Section 4.4.1. Sixty-two sites met this size criterion. Two of the 62 sites are islands in Boston Harbor; the others are all inland sites. Twenty of these sites are State or town parks open to the public [Section 4(f) property], or designated conservation areas, and would therefore be unavailable for materials disposal.

Estimates for the MWRA sites were contained in the site inventory prepared for the MWRA study in 1987 (Residuals Management Facilities Plan, Draft Report on Site Screening Analysis, Volume II - Site Screening Results, Black and Veatch, August 1987). Since the preparation of that inventory, some of the sites have been fully or partially developed, so they may no longer have 80 acres available. The MWRA sites remaining after this screening step were examined in greater detail to determine if this was the case.

The 532 sanitary landfills were also evaluated as potential sites for disposal of fill. However, as discussed in Section 4.4.1, because of the DEP's objections to using the very limited capacity available in the remaining landfills for disposal of materials other than sanitary waste, these sites were not considered practicable because they are not available for this disposal.

Almost all of the inland sites would need a solid waste facility site assignment from the DEP before they could be used for disposal of excavated material. After an application for such a land use is made to the DEP, an evaluation of the potential environmental impacts must be undertaken.

The Solid Waste Act of 1987 set forth 16 considerations to be used in each potential landfill site evaluation. These specify both general and specific limitations for solid waste facilities, and for landfills in particular. (Table 4.10 presents a summary of these criteria, as they apply to landfills.) Eleven MWRA sites were eliminated because they would not meet these minimum siting criteria.

The 4 additional sites identified by real estate brokers are also candidates for disposal of fill based on size and availability criteria. However, three of these sites are no longer practical options:

- Raynham Woods Commerce Center
- Hopping Brook Business Park
- Franklin Industrial Park

All 3 of these sites are office or industrial parks and are already partially developed. The only space remaining at them are individual lots interspersed among office or industrial buildings. The unused lots have available areas of less than 50 acres each.

The fourth identified parcel of land is in East Brookfield. This 235-acre parcel has about 200 usable acres, and therefore was considered as a possible disposal site.

Table 4.10

DEP SOLID WASTE LANDFILL SITING CRITERIA

Affected Resource	**Buffer Zone or Restriction**
Sole Source Aquifer	Conditional Restrictions
Private Wells	500 feet
Height Above Groundwater	4 feet
Occupied Buildings	500 feet
Nondrinking Water Bodies	250 feet
Wetlands	100 feet
Floodplains	Banned
Zone II	Banned
Interim Wellhead Protection Area (IWPA) (0.5 mile radius)	Banned
Upgradient of a Wellhead	15,000 feet
Potential Water Supplies	Banned
Surface Water Supply Upgradient	0.5 mile
Downgradient	500 feet
Streams Feeding a Water Supply Within 1 Mile	250 feet
Agricultural Lands Buffer Zone	100 feet
Area of Critical Environmental Concern	Banned

Source: Massachusetts Department of Environmental Protection (310 CMR 16.00)

Initial Site Screening Summary. The preliminary review described above eliminates 787 of the 848 sites. These sites are eliminated based on size (235 sites), presence of a park or conservation area (20 sites), and DEP sanitary landfill needs (532 sites). Sites eliminated for other reasons are listed below:

- Quincy Quarries East - Previously filled, no capacity remaining.
- Quincy Quarries West - Site dedicated for construction debris disposal.
- Pembroke - Site filled and under preparation for major construction.
- Hypothetical landfill - Replaced by Conrail option, which would include rail to a hypothetical site.
- South Bay Area - Site of a proposed combined sewer overflow (CSO) facility; very low capacity (10,000 cy).
- Squantum Point - Site to be used as parking area/ferry dock by MWRA as part of Deer Island project.
- ASH 18 - Site on Massachusetts 21 E list - Nyanza Hazardous Waste Site.
- ASH 22 - Site adjacent to Nyanza Hazardous Waste Site; pipeline easement reduces fill area to about 80 acres.
- BUR 03 - Residences, power lines, and gas lines on site reduce fill area to less than 100 total/80 net acres.
- CAN 12 - Active recreation area on site.
- CAN 16 - State hospital school on site.
- CAN 20 - Ponkapog Golf Course on site.
- MIL 02 - Residential development on site reduces fill area to less than 100 total/80 net acres.
- NAT 07 - Residential development on site reduces fill area to less than 100 total/80 net acres.
- NOR 02 - Site is 60 percent developed (residential/industrial)
- NOR 07 - Hotel/country club complex on site.
- QUI 07 - Site is on Massachusetts 21 E list.
- QUI 08 - Site is superfund hazardous waste site.
- RED 03 - Site is National Guard reservation and training camp.
- RED 04 - Central part of site is Board of Public Works land, including a water purification station.
- STO 05 - Transfer station closed landfill on site.
- STO 06 - Development on site, and powerline right-of-way, reduce feasible fill area to less than 50 acres.
- WES 02 - Office park under construction on site; fill area reduced to less than 100 total/80 net acres.
- WLP 08 - Site has already been chosen as location for MWRA residuals landfill.
- WLP 12 - Site designated for Norfolk County Agricultural School.
- Long Island - Site of the Long Island Chronic Disease Hospital and a homeless shelter.
- Thompson Island - Site of Outward Bound Education Center.
- BEL 07 - Availability - private county clubs or golf courses.
- MEL 06 - Availability - private county clubs or golf courses
- NEW 04 - Availability - private county clubs or golf courses.

- WNC 01 - Availability - private county clubs or golf courses.
- BED 09 - DEP landfill siting criteria: occupied buildings (seminary and college) at edge of site; 500-foot buffer cannot be maintained.
- BRN 12 - DEP landfill siting criteria: active reservoir adjacent to site.
- BUR 03 - DEP landfill siting criteria: residences at edge of site; 500-foot buffer cannot be maintained.
- CAN 17 - DEP landfill site is 70 percent wetlands; 100-foot buffer to wetlands cannot be maintained.
- HLB 11 - DEP landfill siting criteria: active reservoir adjacent to site
- HLB 12 - DEP landfill siting criteria: 75 percent of site is in floodplain; 70 percent on medium-yield aquifers
- HLB 13 - DEP landfill siting criteria: wetlands on site provide direct hydrological connection to surface water reservoir within 1 km (Weymouth Great Pond)
- LEX 04 - DEP landfill siting criteria: site is 60 percent wetlands; 100-foot buffer to wetlands cannot be maintained
- WLP 14 - DEP landfill siting criteria: 90 percent of site is in floodplain
- WIL 10 - DEP landfill siting criteria: residences surround site; 500-foot buffer to occupied buildings cannot be maintained
- WOB 10 - DEP landfill siting criteria: university campus adjacent to site; 500-foot buffer to occupied buildings cannot be maintained.
- WLP 13 - In Zone II aquifer recharge area.
- WLP 15 - In Zone II aquifer recharge area.
- STO 04 - Residential development would be displaced.
- Chelsea Creek - Dike construction and barge unloading operations would restrict navigation on Chelsea Creek. Construction of dikes would be unreasonably expensive for the small volume of material which could be contained at the site (300,000 cy).
- Conrail - Cost for rail transport option would be about triple that for barge or truck option, on a per cy basis.
- North End Park - Construction of massive dikes would be unreasonable expensive for the relatively small volume of materials contained at the site (900,000 cy). Truck access to site would be through an active park.
- Providence Harbor - Site dedicated for disposal of local dredge materials.

The practicability site screening analysis of 848 possible disposal sites results in a determination of nine sites, shown in Table 4.11, that initially appear to be practicable for use by the project. These sites are examined in greater detail below.

Table 4.11

SUMMARY OF POTENTIAL MATERIALS DISPOSAL SITES THAT MET INITIAL SCREENING CRITERIA

Inland Sites

BED 10 (Bedford)
MAL 01 (Malden)
East Brookfield
WEY 13 (Weymouth)

Marine Sites

Governors Island Flats
Hull Bay
Logan Airport North
Logan Airport West
Spectacle Island

Source: Bechtel/Parsons Brinckerhoff

4.8.4 Description Of Existing Conditions At Potential Disposal Sites

In this section, detailed information is provided for each of the nine potential disposal sites. A brief description and map are included for each site. Only portions of some sites are proposed as disposal areas.

A more detailed illustration of existing conditions for all the proposed disposal sites including Non-Tidal Waters, Substrate, Suspended Particulates and Turbidity, Water, Biological Conditions, and Inland Wetlands may be obtained from the Draft Aquatic Resources Functions And Values, Volume II, Material Disposal Alternatives, Bechtel/Parsons Brinckerhoff, April 1990.

A more detailed illustration of existing conditions for the proposed Malden/Revere disposal site including earth resources, water resources, site conditions, ecology, air quality, transportation, noise, land use and visual, socioeconomics and cultural resources may be obtained from the Residuals Management Facilities Plan: Draft Environmental Impact Report, Volume 2 Landfill Sites, February 1989, Black & Veatch which was produced for the Massachusetts Water Resource Authority.

4.8.4(a) Site BED10 (Bedford)

Site Description. This 183-acre site is located southeast of the Concord River in Bedford (see Figure 4.15). The aquatic resources of the site were taken into consideration when the possible volume of materials was calculated. Part of the site (adjacent to the Raytheon property) appears to be used for minor dumping. The remaining part of the site is predominately forest. The surrounding area is vacant open space with the Raytheon parking lot on the eastern side. Hanscom Airfield is located to the southeast. The Bedford well-water treatment plant is to the east on the opposite side of Hartwell Road. A residential area is located to the west side of the site, and a few residential homes are also situated along Hartwell Road on the eastern side of the site.

Aquatic Resources. Two aquatic resource areas have been identified on site: nontidal waters and inland wetlands. A description of substrate, hydrologic, and biological conditions within these resource area is provided below.

Nontidal Waters: Nontidal waters are present on the Bedford site within the banks of Elm Brook and onsite ditches as shown on Figure 4.16. Although USGS topographic maps indicate a small pond in the northwest corner of the Bedford site, it has proceeded through ecological succession to an emergent wetland.

The watercourses on the site consist of Elm Brook and a series of manmade drainage ditches. The ditches range from 4 to 6 feet wide and 1 to 2 feet deep. Their channels consist of layers of accumulated sediment (fine sand and silt) and decaying organic detritus which are approximately 1 foot deep. Elm Brook is deeper and wider than the ditches but has a similar substrate. However, it has less accumulated sediment, most likely a result of seasonal flushing during periods of high water. No chemical information is available on the sediment within any of the watercourses. The sediments had a sulfide odor when sampled in January 1990.

Elm Brook has a drainage area of 1,575 acres at Hartwell Road. Stream flow was estimated using 20 year discharge data from the USGS gaging station of the Shawsheen River near Wilmington, Massachusetts. The average annual stream flow of Elm Brook at Hartwell Road is approximately 4.0 cubic feet per second (cfs). On January 26, 1990, the discharge was measured at 5.0 cfs. The gaged, long-term average, January discharge is 6.0 cfs.

The currents in the drainage ditches and Elm Brook are slow, observed to be less than one foot per second (fps). Some of the ditches are stagnant. The 100 year floodplain of Elm Brook (see Figure 4.17) extends southward (both upstream and downstream) off the site, but is not extensive on site.

Chemical Characteristics Of Nontidal Waters: The Shawsheen River, Elm Brook, and tributaries are classified by the MDWPC as Class B waters. Such waters are to be suitable for protection and propagation of fish and other life, primary and secondary contact recreation, public water supply after appropriate treatment, and agricultural and industrial uses.

In a 1982 study, samples of Elm Brook at two locations indicated that on several occasions the brook had dissolved oxygen concentrations that were below 50 percent of saturation. Solids and nitrogen concentrations were relatively low in the brook, however both phosphorus and coliform levels were high. A total coliform level of 42,000/100 mg/l, with a fecal coliform level of 8,000/100 ml, was measured in June 1982. Manganese was found at a concentration of 0.18 mg/l, iron at 3.5 mg/l, and zinc at 0.15 mg/l.

In a study conducted by the Massachusetts Port Authority, water quality was analyzed in both Elm Brook and the Shawsheen River in December 1984 and October 1985 (Massachusetts Port Authority, 1985). BOD ranged from 2 to 8 mg/l, pH ranged from 5.9 to 6.8, ammonia concentrations were approximately 0.1 mg/l and nitrate levels ranged from 0.38 to 0.64 mg/l.

The only historical data on suspended solids and turbidity in Elm Brook is from the Massachusetts Division of Water Pollution Control (MDWPC) for samples collected at the Hartwell Road culvert and downstream at Great Road in 1982. Those data indicate suspended solids and turbidity in Elm Brook were variable with the higher values found downstream at Great Road. Water leaving the proposed site contained low concentrations of suspended materials and turbidity.

Recent turbidity measurements made at two locations in January 1990, were relatively high, ranging from 20 to 30 NTU. All water on the site contained a dark amber color indicative of the presence of humic materials derived from the peat soils. The high turbidity values are in part the result of the humic coloration.

During both the 1982 and 1989 MDWPC survey, several water quality parameters were in violation of Class B water quality standards. Dissolved oxygen levels below the cold water standard of 6.0 mg/g were found by the MDWPC in both 1982 and 1989. This oxygen level is 59 percent of saturation, which corresponds to values measured by the MDWPC during summer surveys. The pH values measured in 1982 and 1989 are either at the low range of the 6.5 to 8.3 Class B standard or in violation of it. Suspended solids were below the standard of 25 mg/l, with one exception during 1982. Fecal coliform levels measured during 1982 were high and in violation of the standard of 1,000 bacteria per 100 ml; however a 1989 value was well below the standard.

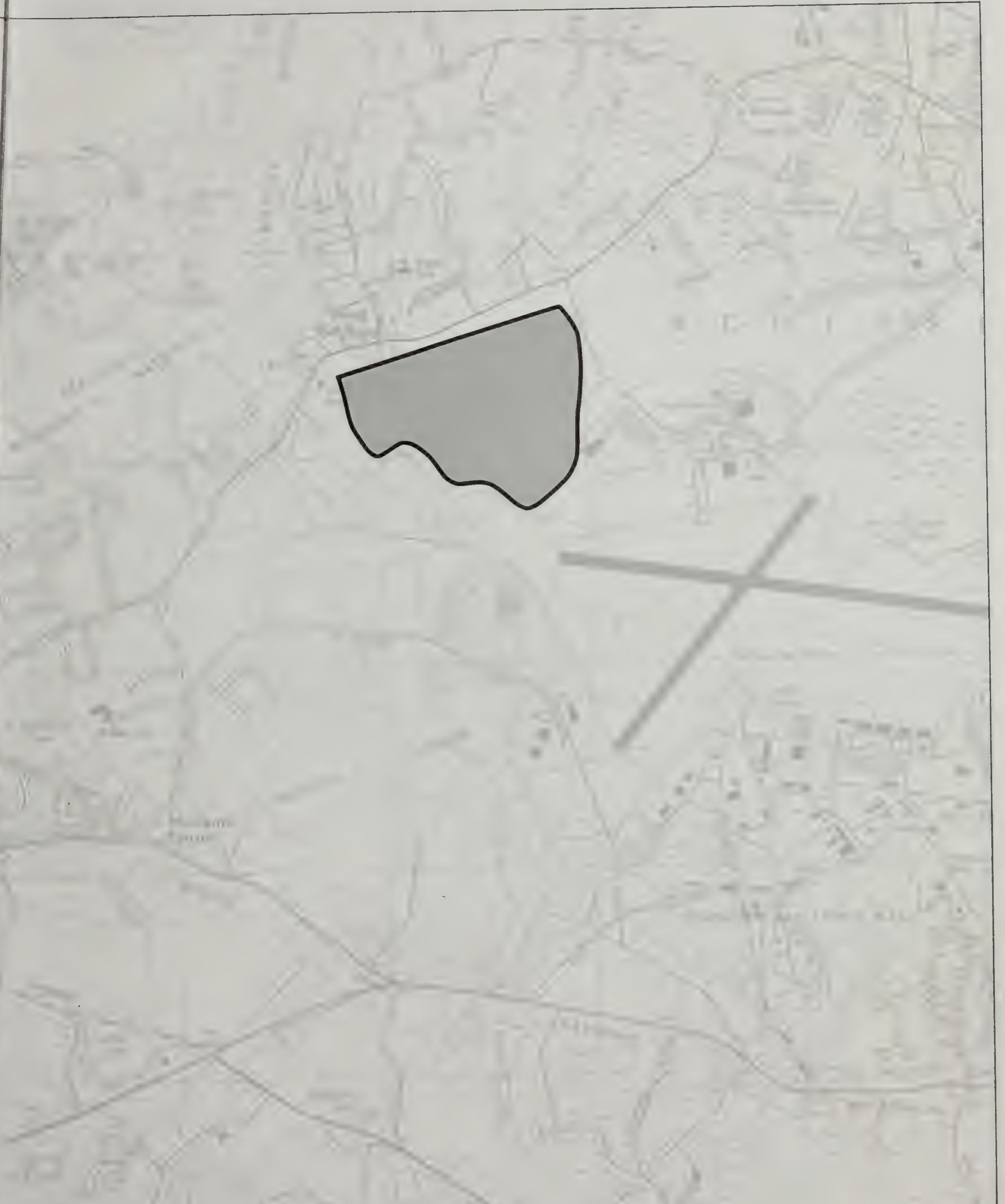


FIGURE 4.15 Site BED10 (Bedford)

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 .5 MILES

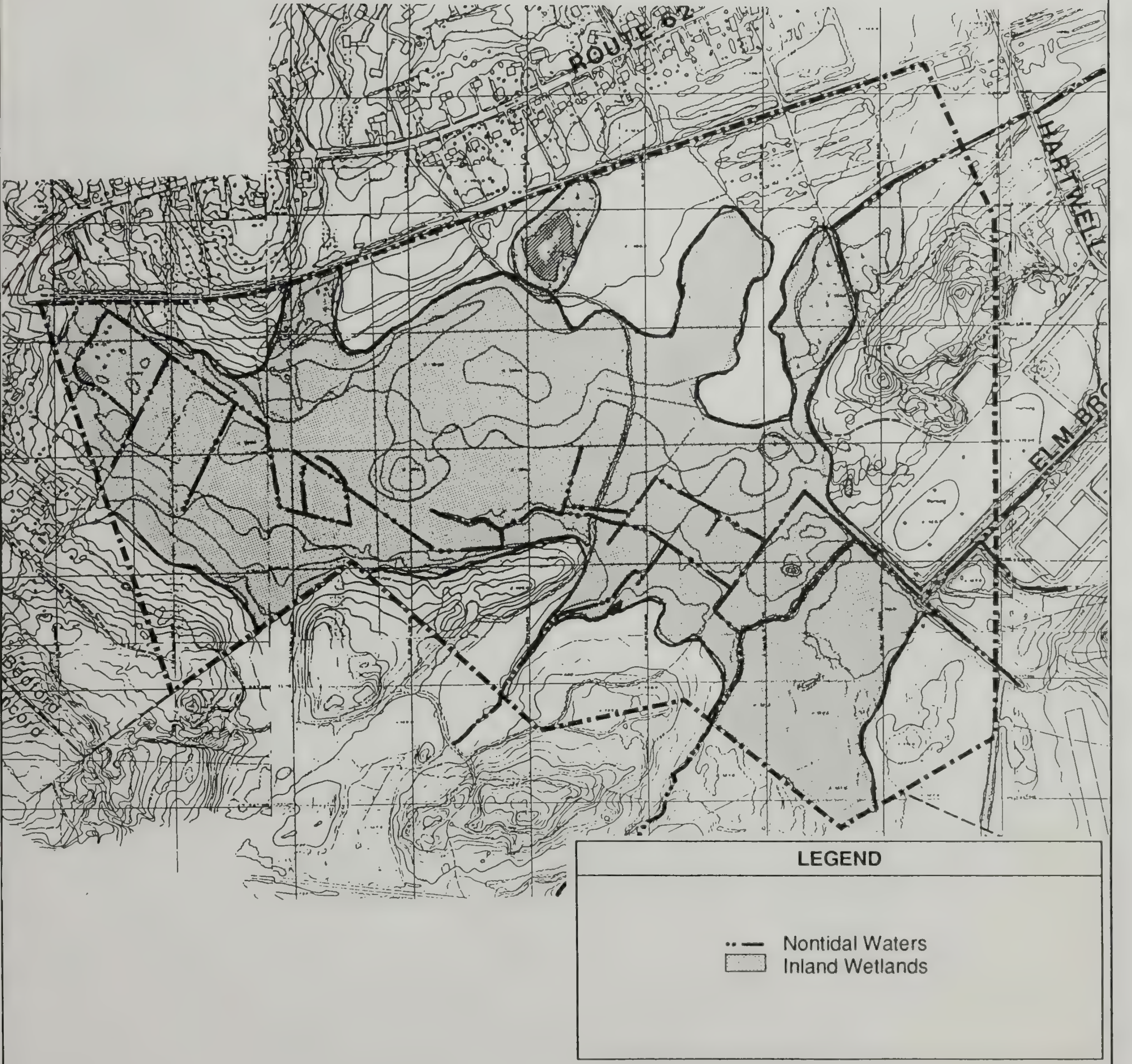
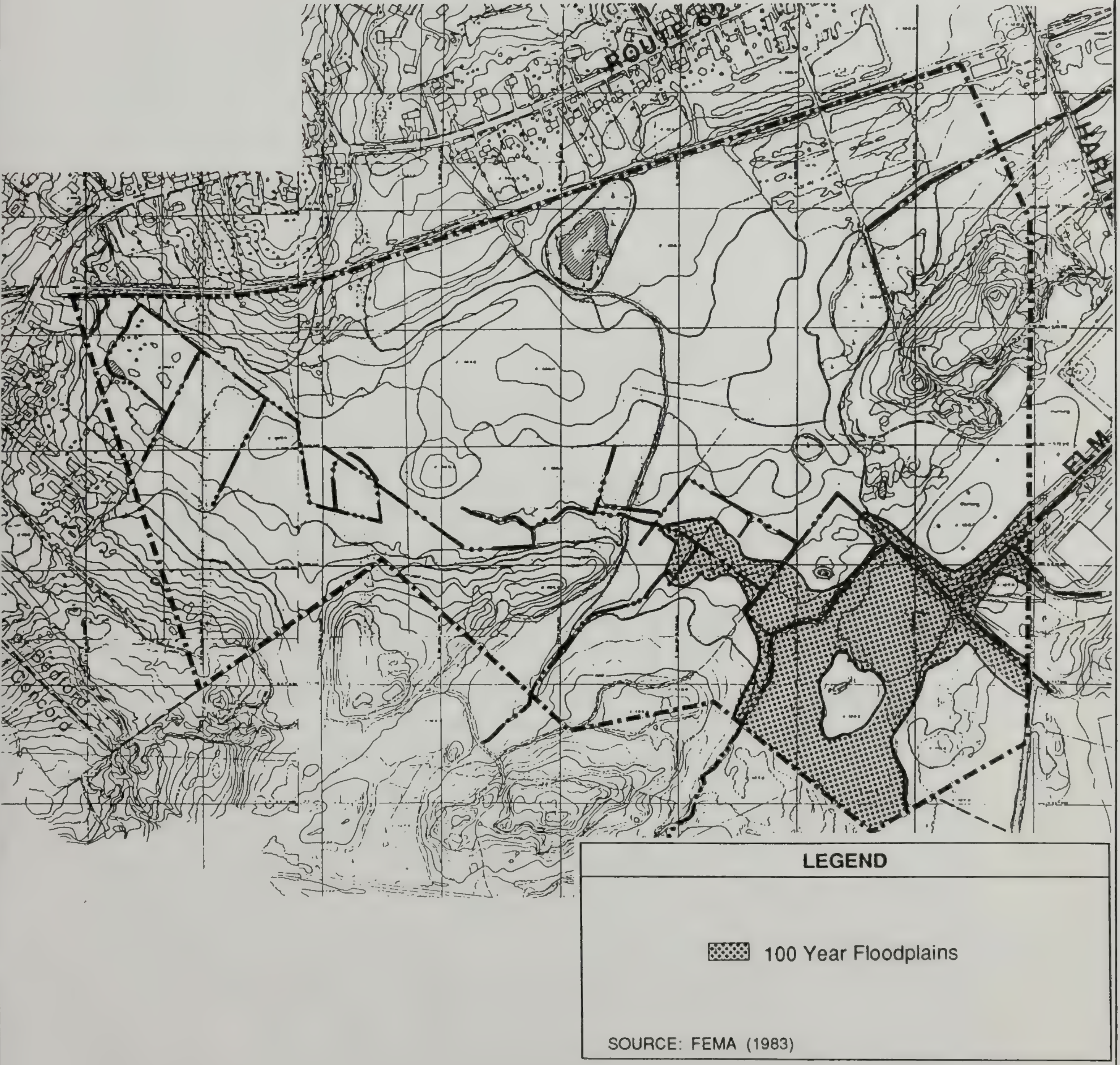


FIGURE 4.16

Bedford Aquatic Resource Areas

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 300 600 FEET



LEGEND

▒ 100 Year Floodplains

SOURCE: FEMA (1983)

FIGURE 4.17

Bedford Floodplains

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 300 600 FEET

Public And Private Water Uses Of Nontidal Waters: Groundwater occurs at shallow depths throughout the site, with wetlands and water courses occurring where groundwater intersects the surface. Even in upland areas, the seasonally high water table is generally within 4 feet of the surface (Soil Conservation Service, 1982). The majority of the site (90 percent) is underlain by a groundwater aquifer, classified as L_1 based on DEP groundwater criteria. This means that it is composed of stratified glaciolacustrine fine- and medium-grained sand deposits possessing transmissivities less than 10,000 gpd/ft (gallons per day per foot of drawdown) or a potential well yield less than 100 gpm (gallons per minute). The remaining 10 percent of the site, a small rounded hill along the eastern site boundary and the northern slope of a larger hill in the southeast corner, is underlain by glacial till and bedrock outcrops, making it classified as LL_1 based on DEP groundwater criteria. These areas generally have a very low transmissivity and do not yield quantities of water suitable for public water supplies. Bedrock underlies the entire site and may yield groundwater to deep wells from fractures and other openings, with yields as great as 120 gpm but generally about 10 gpm (Gay and Delaney, 1980).

The Town of Bedford operates the Hartwell Road Well Field (Wells 10, 11, and 12) approximately 1,000 feet northeast and downstream of the proposed site. While these wells are presently closed because of TCE contamination, they may be used in the future with the aid of an air stripper to remove volatile organic compounds from the groundwater. The capacity of this well field is 828,000 gpd.

In addition, the Town of Burlington uses the Shawsheen River as a drinking water supply. Water is pumped from the River approximately seven miles from the site into the Mill Pond Reserves from which distribution is made. During 1988, Burlington derived approximately 65 percent of its water from the Shawsheen River.

Biological Conditions Of Nontidal Waters: No aquatic vegetation was observed in Elm Brook or the drainage ditches during field investigations made in January 1990.

Elm Brook was sampled for the presence of aquatic invertebrates during January 1990. Qualitative and quantitative samples were collected using a Surber Sampler. Few species were found, and those that were present are common in organic substrates with low oxygen levels.

Elm Brook is annually stocked with brown and brook trout by the Massachusetts Division of Fisheries and Wildlife at a site near Virginia Road upstream of the proposed site. The Brook was surveyed in January 1978 by the MDWPC in response to a heated effluent discharge application. Sampling along the brook identified the presence of the following species. At a station located just downstream of the proposed site, one rainbow trout and one chain pickerel were found. Further downstream at South Road, two white suckers and two eels were found. At the confluence with the Shawnsheen River, one rainbow trout was recovered.

Wildlife diversity and abundance within the ditches and streams on site is moderate. The waterways provide habitat for small amphibians and reptiles, as well as feeding and watering areas for mammals and birds. The generally undisturbed nature of the surroundings increases the habitat value. However, the limited areas of ponded water restricts suitability for waterfowl, and the general uniformity of the ditches further limits wildlife diversity.

Inland Wetlands: Wetland areas total approximately 98 acres, or 53 percent of the site. These boundaries were determined by review of U.S. Soil Conservation Service (Soil Conservation Service, 1982) maps, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps (undated), aerial photography (1981), as well as Bedford Town Wetland maps (Interdisciplinary Environmental Planners, 1976). Wetlands were delineated by Jason M. Cortell and Associates Inc. in the field based on the presence/absence of scrub/shrub and forested vegetation. No detailed field delineation efforts involving the flagging and surveying of precise water/wetland boundaries were undertaken. Without such efforts it was especially difficult to determine wetland boundaries in the ditched, level forested areas that support vegetation transitional between uplands and wetlands.

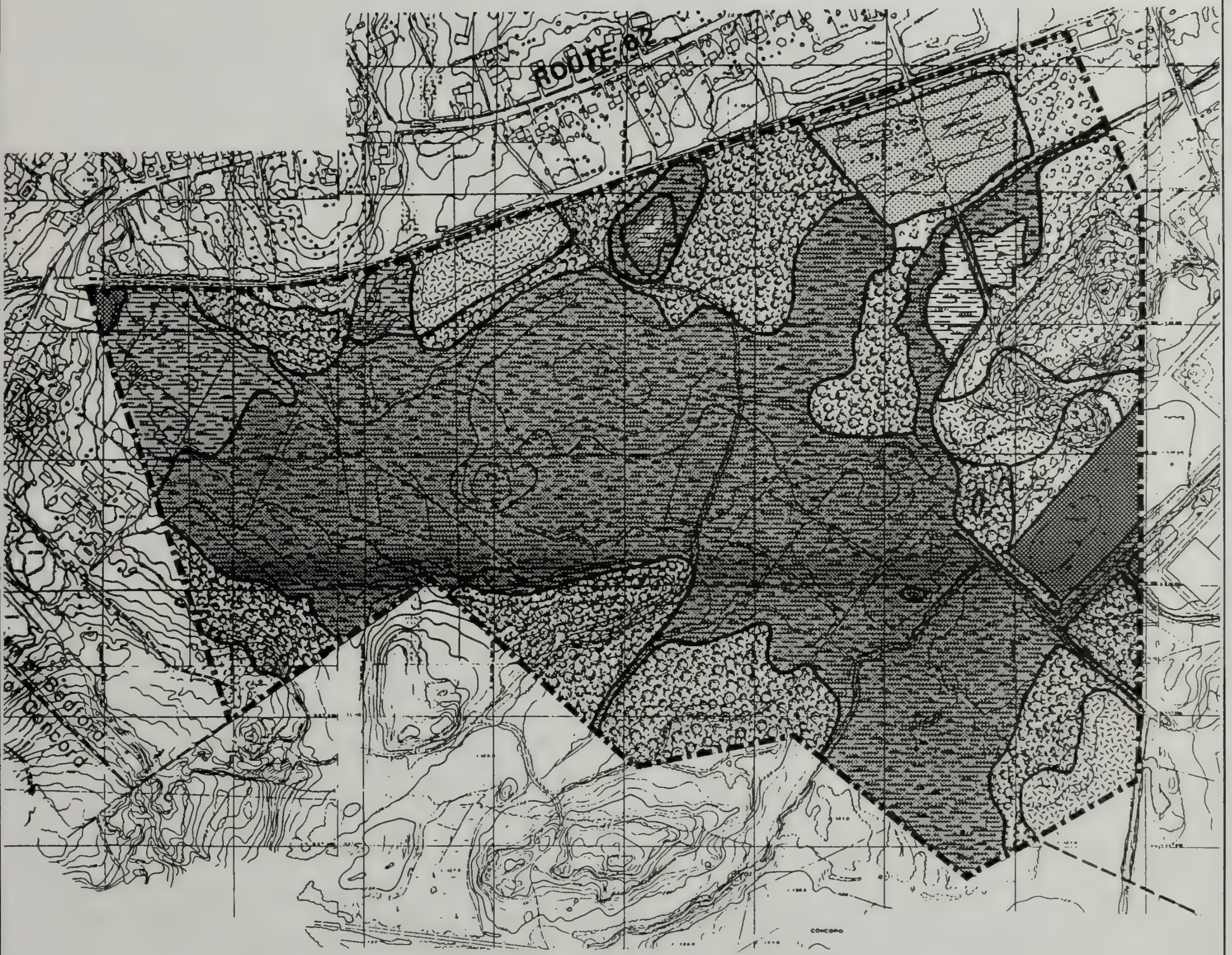
The wetlands on site are not unusual or unique to the area. A large forested wetland occurs to the north, across Concord Road (Route 62). The Great Meadows wetland complex is located to the east. Scrub/shrub-forested complexes occur to both the north and south, somewhat lower and higher in the Elm Brook watershed (see Figure 4.18).

Areas designated as wetlands correspond closely with the occurrence of hydric soils (Soil Conservation Service, 1982). Hydric soils onsite include Freetown muck, Scarboro loamy sand, Swansea muck, and Wareham loamy sand. Even the majority of upland soils (Birchwood and Deerfield) have seasonally high water tables that are close to the surface. Only limited areas of standing water were observed within the wetland areas.

All the wetlands on site drain to Elm Brook and are thus considered one hydrologic unit. Wetland areas range from semi-permanently flooded (surface water present during the growing season) to temporarily flooded (surface water is present during the growing season, but the water table usually lies well below the soil surface for most of the season). The wetter areas occur in the scrub/shrub and emergent marsh in the northwest corner of the property, the depression located north of the trail in the north central portion of the property, and the emergent marsh located near the northeast corner adjacent to the abandoned nursery. The forested areas immediately adjacent to the ditches and Elm Brook also have indications of seasonal surface water. The remaining forested wetlands are transitional, with relatively few indications of surface water, although some mounds and pools can be found in the lower portions.

Terrestrial Habitat and Wildlife. Areas of forested hydrophytic vegetation occupy the central portion of the property and are associated with Elm Brook and the many ditched tributaries that flow into this brook. These areas are composed primarily of red maple, sheep laurel, white pine, sweet pepperbush, red oak, white oak, American elm, common highbush blueberry, cinnamon fern and wintergreen. Except for areas where surface waters occur associated with Elm Brook and its ditched tributaries, much of the forested wetland is transitional, being dominated by facultative species or being composed of a mixture of upland and wetland plant species. While much of the forested wetland is a dense red maple forest, a large area of open canopy elm wetland is evident at the southwest corner of the site. The species composition of this area differs in being dominated by American elm, tussock sedge, marsh fern, purple loosestrife, wool grass, and rough alder.

Two areas of scrub-shrub hydrophytic vegetation occur in the northwestern portion of the property along ditched streams. These areas are dominated by rough alder, silky dogwood, arrowwood, meadowsweet, and sensitive fern.



LEGEND

WETLAND
- ▨ Forested
- ▨ Scrub/Shrub
- ▨ Emergent

UPLAND
- ▨ Mature Forest
- ▨ Successional Forest
- ▨ Early Successinal Field
- ☐ Abandoned Nursery
- ☐ Developed

SOURCE: Cortell (March, 1990)

FIGURE

4.18 **Bedford Vegetative Communities**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 300 600 FEET

Based on field investigations conducted in January, 1990, upland community types on the property consist of mature and successional forests, successional fields, and developed lands. Wetland communities, as previously discussed, include forested, scrub-shrub and emergent areas.

Mature upland forest communities are located along the northern and southern periphery of the property. These communities are dominated by white pine, white oak, red oak, black oak, late low bush blueberry, common highbush blueberry ground pine, and wintergreen.

Successional or disturbed upland forest communities are primarily located along the eastern border of the property adjacent to Hartwell Road. These communities are dominated by gray birch, bigtooth aspen, black cherry, smooth sumac, multiflora rose, tartan honeysuckle, alleghany blackberry, Canada goldenrod, meadowsweet, bracken ferns, eastern hemlock, American yew, northern white cedar, and sugar maple.

Early successional upland fields are located primarily at the northern and southern periphery of the property. These successional communities are dominated by broomsedge, fairy aster, Canada goldenrod, gray birch, and alleghany blackberry.

The remainder of the uplands onsite are composed of developed areas with landscaped and mowed areas, buildings, roadways and parking lots. Developed areas are located in the southeastern portion of the property adjacent to Raytheon on Hartwell Road.

Threatened and Endangered Species. No wildlife species on the State List of Endangered and Threatened Wildlife and Plants (321 CMR 8.00; October 16, 1986) or the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12; August, 1988) were observed on site. The Atlas of Estimated Habitat of State-Listed Rare Wetlands Wildlife (Natural Heritage and Endangered Species Program, 1989) indicates that suitable habitat for rare wetlands wildlife occurs in the Great Meadows National Wildlife Refuge less than 0.25 mile from the northwest corner of the site. However, the species type is not identified. Unless the species is mobile, such as a bird, it is not likely that the habitat range extends to the Bedford site.

4.8.4(b) Site MAL01 (Malden/Revere)

Site Description. This site in Malden is Rowe Quarry, and it has been a 57-acre active quarry since 1885 (see Figure 4.19). The site is located off Route 1 North with access from Lynn Street. From East Boston, automobile travel time is slightly over 19 minutes in off-peak travel periods, a distance of 6 miles. The site is surrounded on the north, south, and west by residences, including some condominium development. However, this development appears to be reasonably well buffered by forest, open space, and Route 1.

The MA Coastal Zone Management (MA CZM) boundary in this area is defined by the eastern side of Lincoln Avenue (Salem Street) between the Saugus/Revere town line and the Route 1 intersection, and then follows Route 1 to the south. The portion of the property located to the southeast of Lincoln Street (Salem Street) is, therefore, within the MA CZM boundary, as shown on Figure 4.20.

The Saugus/Pines River marsh is located to the east. Portions of this area have recently been designated as an Area of Critical Environmental Concern (ACEC) by MA Executive Office of Environmental Affairs. As indicated on Figure 4.20, a portion of the site located southeast of Lincoln Avenue (Salem Street) is within the ACEC boundary.

Aquatic Resources. Although the quarry disposal site is approximately 57 acres, the study area included 89 additional acres surrounding the site. The aquatic resources mapped on site are coastal and inland wetlands. No tidal or non-tidal waters are present on the site. A description of substrate, hydrologic, and biological conditions is provided below.

Inland Wetlands: Inland wetlands total approximately 3 acres, or 2 percent of the site. Three areas of ponded open water, that are designated on NWI maps as in the quarry, no longer exist. A fourth open water area outside the quarry has apparently been disturbed by filling or excavating and now supports a scrub-shrub wetland.

These wetlands correspond closely with the occurrence of hydric soils (Soil Conservation Service, 1982, 1987). Hydric soils include Ipswich mucky peat and Swansea muck.

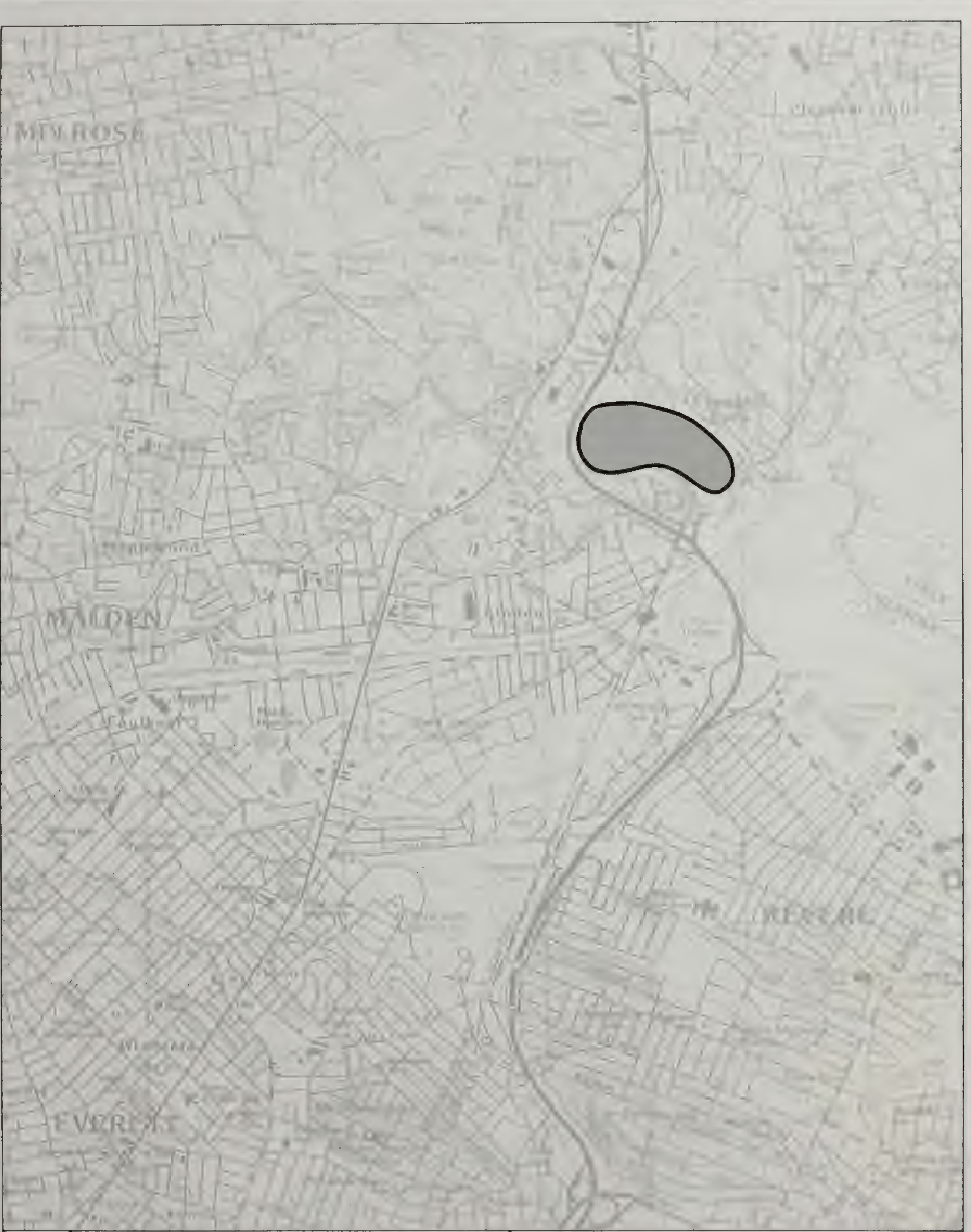
Based on field investigations conducted in January 1990, upland community types on the property consist of mature and successional forests, successional fields, and developed lands. The wetlands are considered isolated hydrologic units, although several community types are present. Wetland communities, as subsequently discussed, include forested, scrub-shrub, and emergent areas. These wetlands are typical of the region.

Biological Conditions Of Inland Wetlands: One area of scrub-shrub hydrophytic vegetation occurs in the northwestern portion of the property adjacent to the forested wetland. These areas are dominated by pussy willow, purple loosestrife, meadowsweet, and reed grass. This area has apparently undergone much disturbance as piles of rubble are covered by reed grass, making the boundaries of the wetland not easily determined (see Figure 4.21).

Two areas of emergent hydrophytic vegetation occur in the southern portion of the site. One area occurs near the entrance of the quarry and appears to be composed solely of reed grass. The other emergent area occurs in the middle of the access ramp for U.S. Route 1 and is composed primarily of swamp milkweed, purple loosestrife, and soft rush.

The substrate of the reed grass stand within the quarry is assumed to be bedrock. Despite the statement that the wetland in the northeastern part of the site "appears to be filled land now" (Black & Veatch, 1988), it is believed that this wetland does contain Swansea muck, at least in part, as originally described in the SCS soil survey (1987). It is assumed that the reed grass stand located on the floor of the quarry is subjected to frequent inputs of sediment from adjacent operations.

The reed grass stand is isolated from any adjacent surface waters. Most likely it was established when a depression was made during quarry operations, and is driven by runoff entering the depression. The other two wetlands are also hydrologically isolated. 100-year floodplains are designated (FEMA, 1987) for the wetland at the northeastern corner of the site.

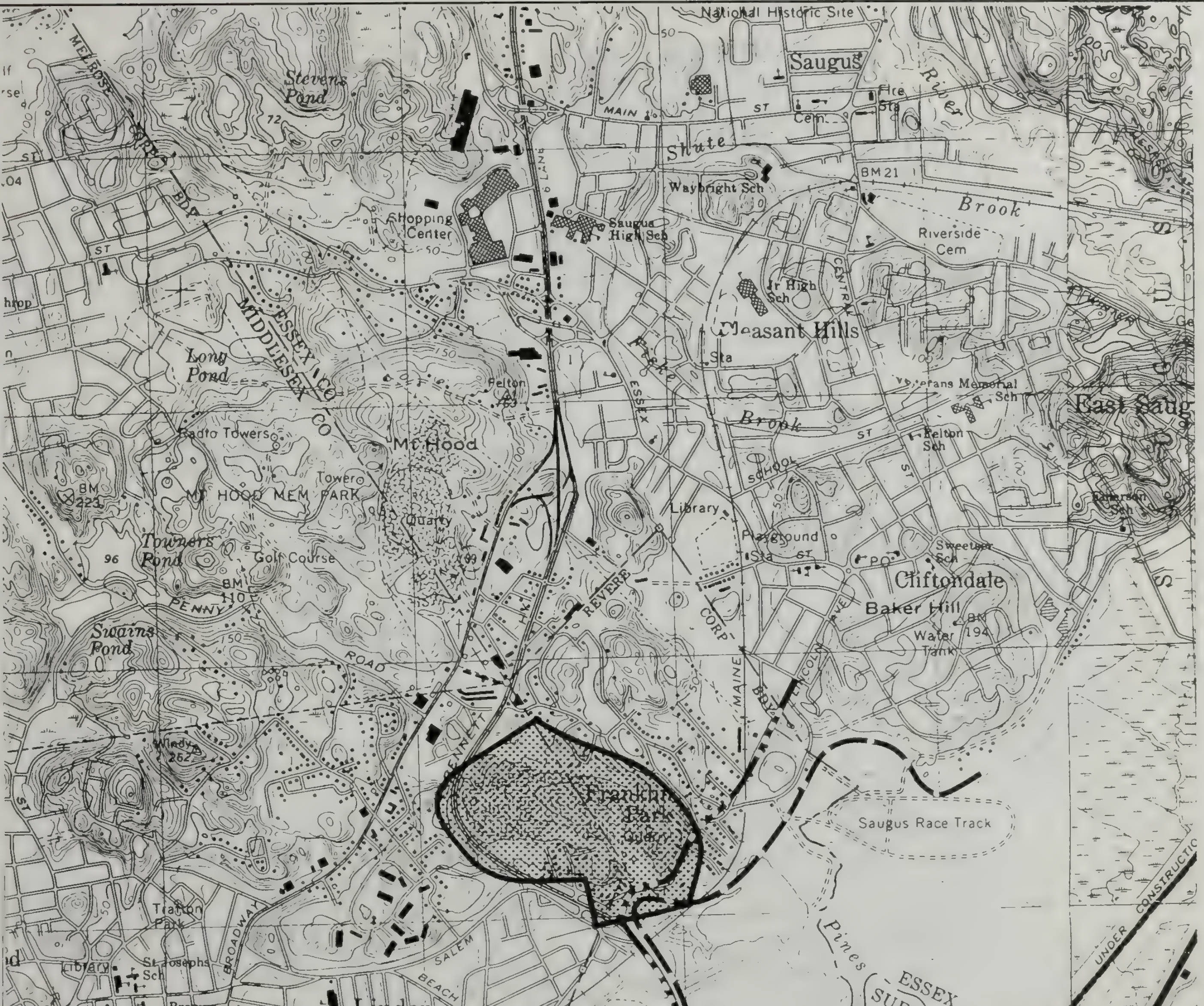


FIGURE

4.19 **Site MAL01 (Rowe Quarry)**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93) TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 .5 MILES



LEGEND

▒ Malden Disposal Area
— — ACEC Boundary
–·–·– MA CZM Boundary

SOURCE: U.S.G.S. Boston, North Quadrangle (1971, Photorevised 1979) & U.S.G.S. Lynn Quadrangle (1970)

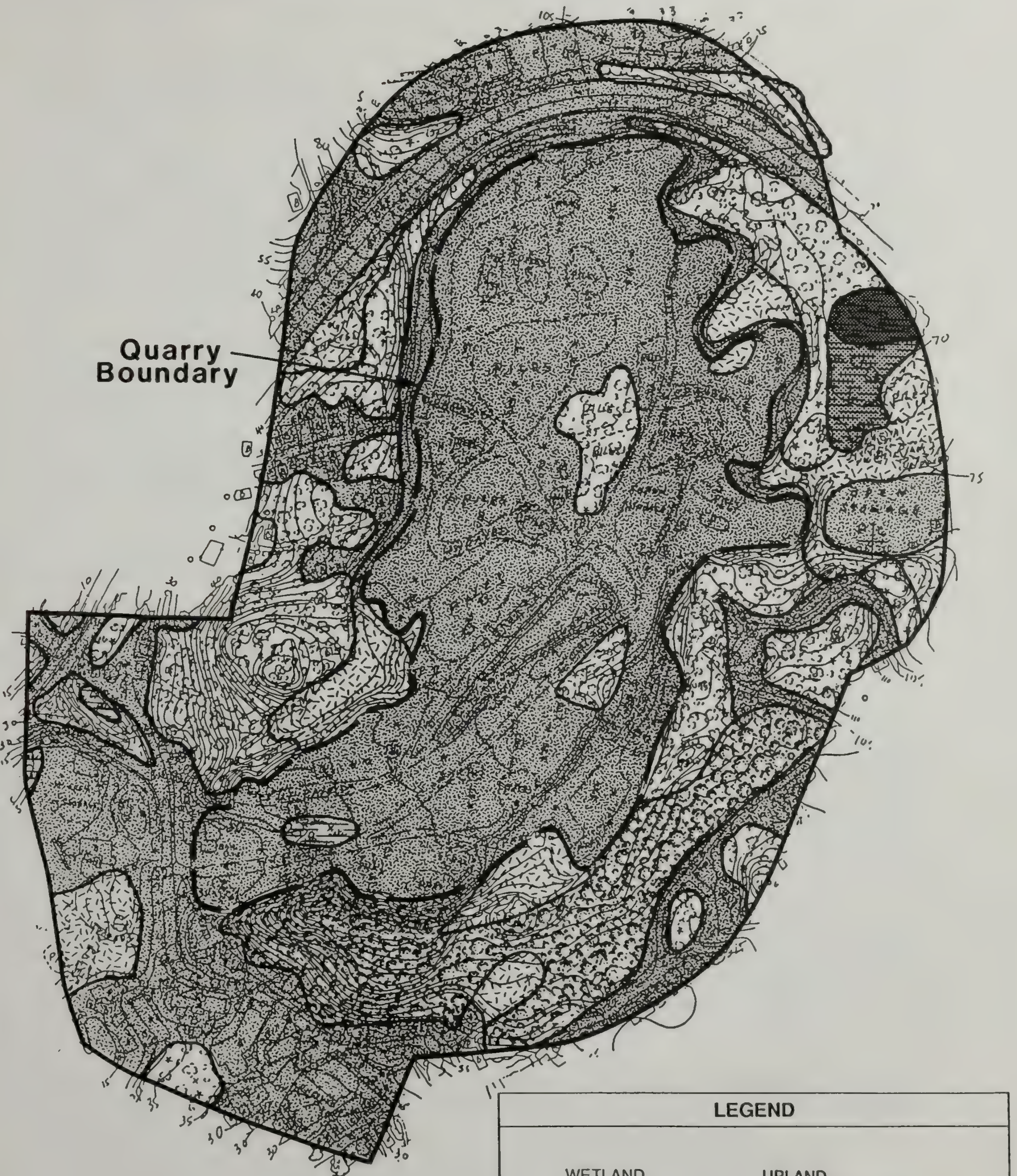
FIGURE

4.20

Malden Site Location Map

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 2083 Feet



SOURCE: Cortell (March, 1990)

FIGURE 4.21

Malden Vegetative Communities

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 420 Feet

Public and Private Uses of Inland Wetlands: No known public or private water supply uses occur in any of the inland wetlands.

Coastal Wetlands: On site coastal wetlands are limited to a small and tidally influenced reed grass stand located in the southeast corner of the site. This wetland is approximately 0.5 acres and occupies less than 1 percent of the site. The reed grass stand is connected to the adjacent salt marsh by a culvert under the railroad tracks. Although it is not clear if normal tidal ebb and flow occur in the reed grass stand, it is assumed that at least periodically (i.e., during a storm) sea water enters this wetland.

The substrate of the reed grass stand has not been examined. However, the 1982 SCS maps indicate that salt marsh peak (deep Ipswich mucky peat) likely underlies the area. No other information is available.

No water quality samples have been obtained for this area. However, visual observations indicate that surface waters drain from Salem Street into the wetland. This surface water runoff would include sediments from trucks entering and exiting the quarry area.

The 100-year floodplain (see Figure 4.22) of the Pines River encompasses this coastal wetland and extends eastward off the site, but it is not extensive on site.

Biological Conditions Of Coastal Wetlands: The one coastal wetland constitutes an area of emergent hydrophytic vegetation. Although this wetland may have, at one time, supported a diverse array of salt marsh species, it is now composed solely of reed grass.

The aquatic invertebrate population in the coastal wetland has not been sampled. However, the coastal wetlands adjacent to the site (Rumney Marshes) contain numerous species of marine macroinvertebrates. Samples collected closest to the site at the Seaplane Basin were dominated by *Capitella capitata,* and an oligochaete worm. Other species found include *Streblospio benedicti*, *Polydora ligni*, *Aricidea catherinae*, and *Caulleriella* sp. (U.S. Army Corps of Engineers, June 1989). No open water is present within this area. Therefore, the wetland does not have any fisheries habitat.

No shellfish have been observed within the wetland area on the site. However, soft-shelled clams have been reported in nearby tide channels (U.S. Army Corps Of Engineers, June 1989). Other studies have indicated that ribbed mussels, blue mussels, horse mussel, and numerous other species inhabit the adjacent wetlands and tide channels. These shellfish beds have been closed to harvesting because of bacteriological contamination.

Public and Private Uses Of Coastal Wetlands: No known public or private water supply uses occur in the coastal wetland. The presence of salt marsh peat suggests it is unlikely that the area recharges to groundwater.

No known public or private water supply uses occur in any of the inland wetlands.

In non-aquatic portions of the quarry, groundwater at the site lies at shallow depths, from 1 to 3 feet beneath the quarry floor. While highly fractured near the surface and less fractured at depth, this rock quarry provides a good conduit for precipitation and surface waters to enter the groundwater system (Black & Veatch, 1988). The USGS has mapped the site and surrounding areas on the basis of groundwater favorability (Delaney and Gay, 1980). Having mostly exposed bedrock with undisturbed upland areas mantled by glacial till, the site is a poor groundwater aquifer. Wells penetrating bedrock must intersect water-filled fracture zones, and then the well yield is expected to be low, on the order of 10 gpm (gallons per minute) or less. Areas surrounding the site are underlain by stratified glacial deposit aquifers of low (0 to 100 gpm) to medium (100 to 300 gpm) yields. Thus, it is classified as LL_1 based on DEP groundwater criteria.

Terrestrial Habitat and Wildlife. Mature upland forest communities are limited to the northeastern portion of the site. These communities are dominated by white oak, red oak, black oak, black cherry, common highbush blueberry, and woodland sedge.

Successional or disturbed upland forest communities are scattered around the periphery of the quarry and also occur on abandoned piles within the quarry. These communities are dominated by gray birch, black oak, black cherry, smooth sumac, staghorn sumac, black locust, Allegheny blackberry, Canada goldenrod, and common greenbrier.

Early successional upland fields are also scattered throughout the property. These successional communities are dominated by broomsedge, fairy aster, Canada goldenrod, love grass, spotted knapweed, bouncing Bet, common haircap moss, and common mullein.

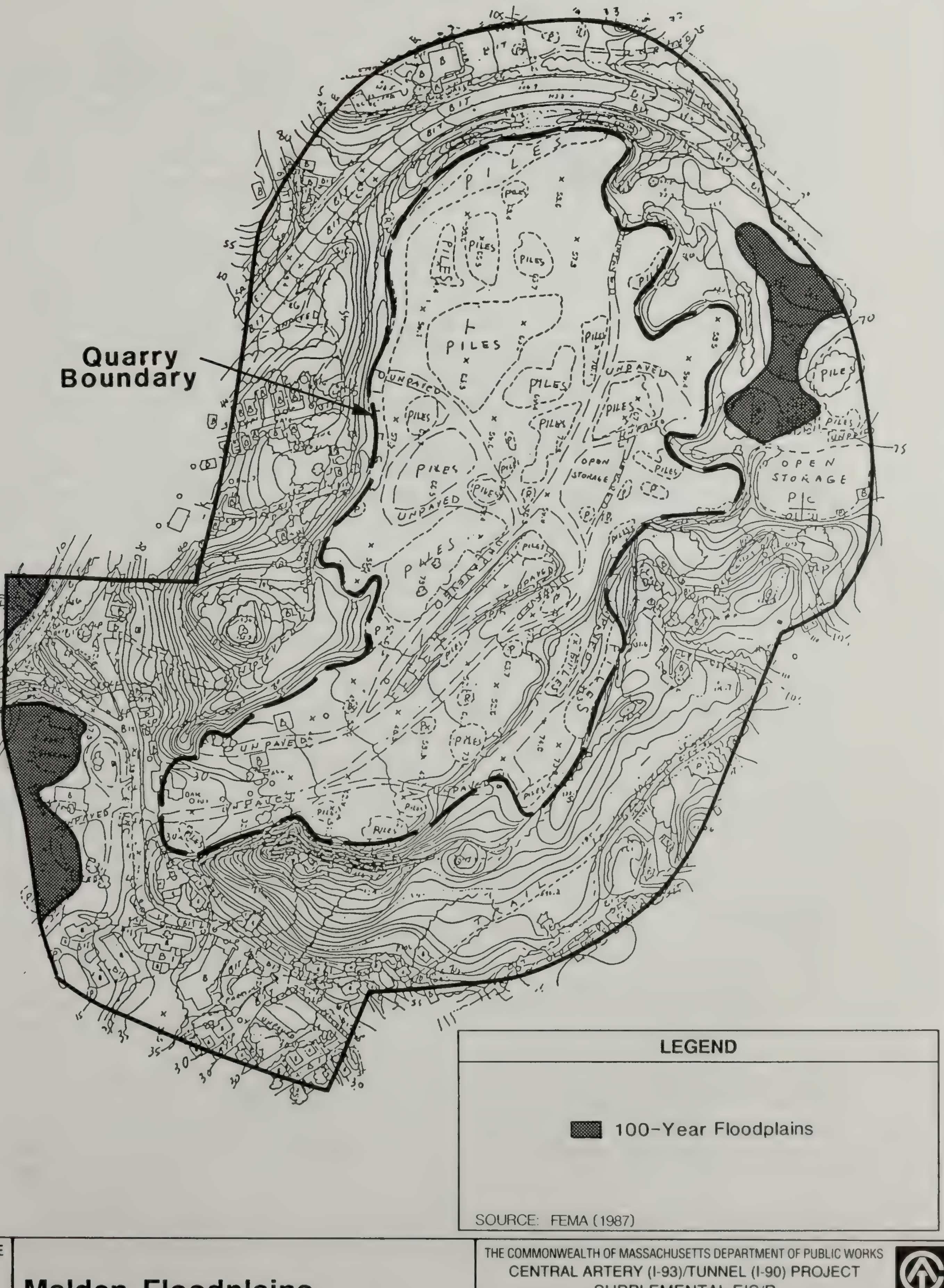
The remainder of the uplands on site are composed of developed areas that include landscaped and mowed areas, buildings, roadways, parking lots and quarries. Quarries, which occupy a large part of the central portion of the property, account for most of the developed area.

Although there are no site specific data on aquatic invertebrates that could inhabit these nontidal wetlands, it is common for numerous species of invertebrates, especially true flies, beetles, and striders, to inhabit small permanent or temporary pools and wetlands.

Wildlife diversity and abundance within the quarry wetland area is limited by the small, uniform habitat. Reed grass does not offer quality wildlife habitat. Additionally, the small size of the area as well as surrounding disturbances severely limits the ability of the area to provide wildlife habitat.

The small emergent wetland in the southwest corner is located in the Route 1 ramp and therefore supplies minimal wildlife habitat. The forested/scrub/shrub wetland, although surrounded by disturbed and developed areas, most likely provides somewhat better habitat as it contains a more diverse food supply.

Threatened and Endangered Species. No wildlife species on the State List of Endangered and Threatened Wildlife and Plants (321 CMR 8.00; October 16, 1986) or the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12; August, 1988) were observed on site. The Atlas of Estimated Habitat of State-Listed Rare Wetlands Wildlife (Natural Heritage and Endangered Species Program, 1989) does not indicate that any suitable habitat exists for rare wetlands wildlife within 1.5 miles of the site, although the site drains into such an area along the Pines River about 1.5 miles downstream. Additionally, correspondence with the Massachusetts Natural Heritage Program and U.S. Fish and Wildlife Service (Black & Veatch, 1988) indicated that no rare plants, animals or natural communities and no federally listed or proposed threatened or endangered species have been reported or are known to occur in the site area.



SOURCE: FEMA (1987)

FIGURE

4.22 **Malden Floodplains**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

4.8.4(c) Site WEY13 (Weymouth)

Site Description. The Weymouth site is located north of Route 3, south of Washington Street, east of Pleasant Street, and west of the Hingham town line (Figure 4.23). Automobile travel time from downtown Boston is approximately 25 minutes during off-peak periods with a distance of 18.6 miles. Surrounding the site are a few light industrial areas along with some residential and commercial development on the approaches along Whiting and Pleasant Streets.

The site is approximately 130 acres, and currently supports an operating quarry as well as forested and successional lands. The quarry area totals approximately 62 acres, of which approximately 9 acres consist of open water and wetlands. The Plymouth River, a tributary of the Weir River, flows through the southwestern corner of the site. The Weir River flows into the Weir River Area of Critical Environmental Concern (ACEC) 7 miles downstream from the site (Massachusetts Coastal Zone Management, 1987). This area is noted for its high biological productivity, active anadromous fish run, and its shellfish resources.

Upland community types on the property consist of mature and successional forests, successional fields, and developed lands. Mature upland forest communities are limited to the northern half of the property. These communities are dominated by white pine, white oak, red oak, black oak, American beech, common highbush blueberry, and wintergreen.

Successional or disturbed upland forest communities are scattered throughout the periphery of the quarry. These communities are dominated by white pine, gray birch, bigtooth aspen, staghorn sumac, smooth sumac, black huckleberry, sweetfern, pineweed, Allegheny blackberry, Canada goldenrod, wintergreen, haircap moss, and bracken fern.

Early successional upland fields are located primarily in the northern half of the property. These successional communities are dominated by smooth sumac, fairy aster, pokeweed, bouncing Bet, Canada goldenrod, common mullein, alleghany blackberry, foxtail, panic grass, broomsedge, and autumn bentgrass.

The remainder of the uplands on site are composed of developed areas that include landscaped and mowed areas, buildings, roadways, parking lots and quarries. Quarries, which occupy a large part of the central and southeastern portion of the property, account for most of the developed area.

Aquatic Resources. Three aquatic resource areas have been mapped on site: non-tidal waters, natural ponds, and inland wetlands.

Nontidal Waters: Nontidal waters are present on the Weymouth site within the banks of Plymouth River and on site streams.

Aquatic substrates vary throughout the site. The unnamed stream that drains the north end of the quarry and flows northward has a bottom consisting of sand and pebbles. The Plymouth River draining the western border of the site has a bottom of fine sand and silt, with few pebbles. The substrates of the flowing waters on the site serve as habitat for a variety of macroinvertebrates.

The USGS maintains a gaging station (01090001) on the Old Swamp River at a location approximately one-half mile west of the site. The period of record is 1966 to present. The average discharge of the River is 9.29 cfs (2.2 cfs) or 28 inches of runoff per year. Therefore the site has an average discharge rate of 0.4 cfs or 14 million cf annually. Discharge was measured at three locations and flows ranged from 2.5 to 9 cfs. Water flow velocity on the site ranged from zero to 1.75 feet per second (fps).

Both the Plymouth River and the unnamed stream on the site have defined channels, but flow through areas of shallow topography. During periods of high flow, the waters rise and expand out of their channel into the floodplain and occupy a larger surface area.

The 100-year floodplain (Figure 4.24) of the Plymouth River extends both upstream and downstream off the site but is not extensive on site.

The Plymouth River and tributaries are classified as Class B waters. These waters are to be suitable for the protection and propagation of fish and other life, primary and secondary contact recreation, public water supply with appropriate treatment, and agricultural and industrial uses.

Flowing water on the site met the Class B standard for dissolved oxygen. Hydrogen ion (pH) levels varied, with the water draining the quarry being slightly below the minimum of 6.5 units in the Class B standards. The pH level was particularly low in the wetland waters.

Turbidity measurements made in January 1990 indicate the water had low to moderate turbidity levels. Water in the Plymouth River contained some visible suspended solids as well as humic coloration.

Biological Conditions Of Nontidal Waters: No aquatic vegetation was found on site in the Plymouth River or other watercourses during field investigations in January 1990.

In the stream draining the quarry, caddisflies were the only aquatic invertebrates found. The Plymouth River contained five species of benthic macroinvertebrates. Several of these species are not tolerant of pollution, indicating clean water quality conditions.

No fisheries data are available for the site or the Plymouth River. It is unlikely that the stream draining the quarry serves as important fish habitat because of its shallow and probably intermittent nature. The Plymouth River is deeper, well oxygenated and shaded, and may serve as habitat for warm water fish. The MDFW does not presently stock the river. The extent of a cold water fishery, if any, is not known. However, the Weir River is well known for its fishery and anadromous fish runs.

The wildlife habitat of the tributary draining the quarry is minimal because of the area's disturbed nature. The Plymouth River, however, provides habitat for amphibians and reptiles, and acts as a water source for mammals and birds.

Public And Private Uses Of Nontidal Waters: There are no known public or private water uses on the site, although the quarry operation may use some water for process needs.

Groundwater at the site lies at shallow depths beneath ground surface. Where groundwater intersects the surface, wetlands, swamps, streams, and rivers can be found. In some areas

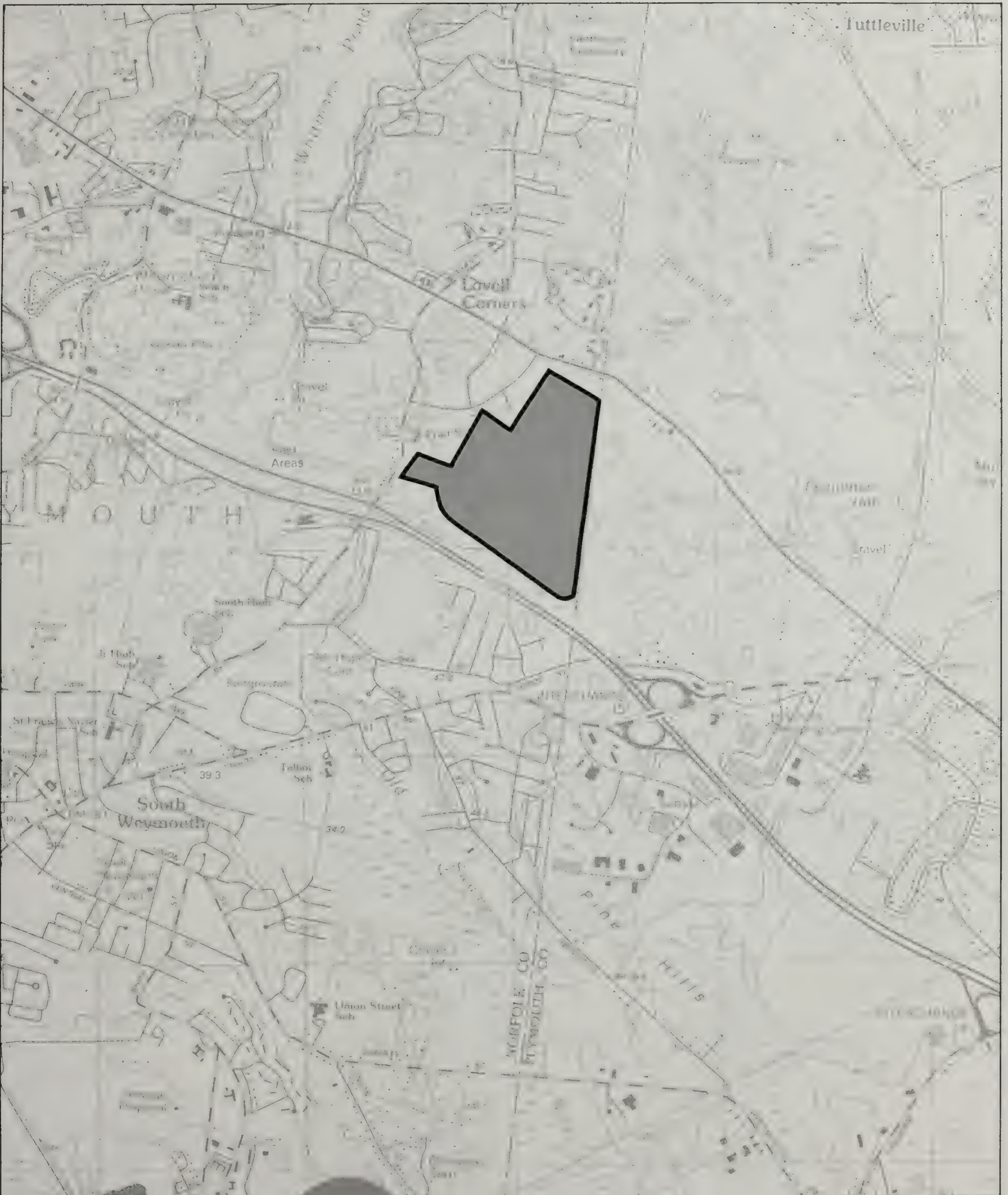


FIGURE 4.23 Site WEY 13 (Weymouth)

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 .5 MILES

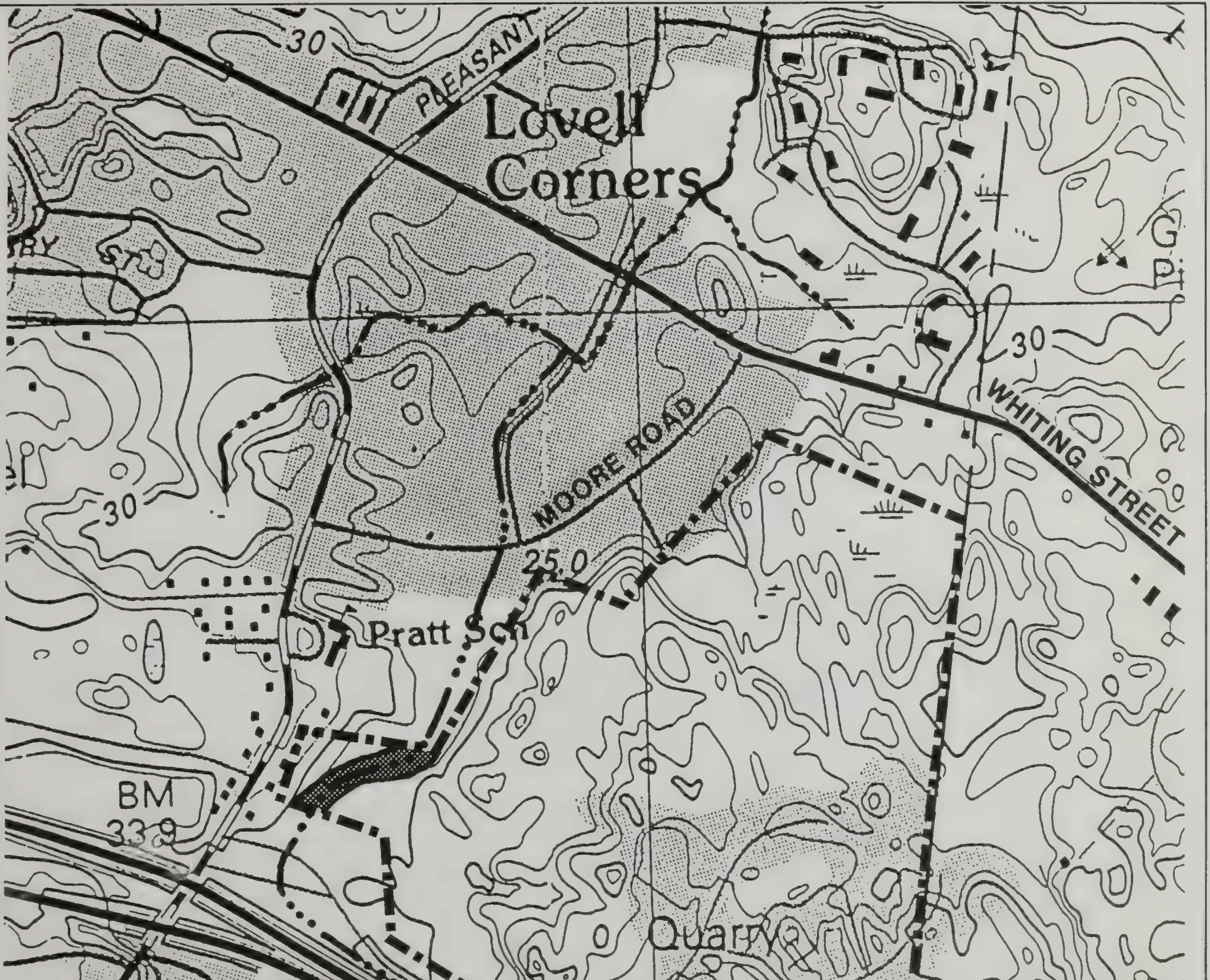


FIGURE 4.24 **Weymouth Floodplains**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 725 Feet

groundwater is perched atop an unfractured granite surface or impermeable glacial till. The swamps in the central and northeastern part of the site lie at an elevation 20 to 30 feet above the Plymouth River, and the surface water and groundwater is probably in a perched condition.

The USGS has mapped the site and surrounding areas on the basis of groundwater favorability (Williams and Tasker, 1974). The majority of the site (60 percent) is classified as unfavorable for the development of groundwater because it is underlain by glacial till and bedrock which have very low transmissivities. This would give it an LL_1 classification based on DEP groundwater criteria. The remaining 40 percent of the site is underlain by glacial stratified drift classified as having a low transmissivity of less than 10,000 gpd/ft or a potential well yield of less than 100 gpm (gallons per minute). This would make it an L_1 aquifer based on DEP groundwater critieria (DEP, Water Supply Atlas Handbook, 1989).

Natural Ponds: Several ponded areas are on the site. Although these ponds are not natural, in that they have been formed by quarry activities, they are discussed here rather than as nontidal waters. The ponds occupy approximately 7 acres (5 percent) of the site. The current USGS topographic map indicates a large pond on the east border of the site, that does not, in fact, exist. The area is damp, with numerous dead conifers, but it contains no standing water. Because of access constraints, observations were made only at the pond on the north central portion of the site. Some additional data on the remaining ponds were compiled through the use of aerial photographs and soil maps.

The pond located on the north central portion of the site is disturbed by extensive digging, and has an 8-inch pipe entering it that appears to be for water withdrawal. Its substrate consists of pebbles, cobbles, and boulders, with some silt. According to an SCS map, this area was formerly hydric soils.

The pond observed on the northern portion of the site did not have an inlet or outlet. It appears to be connected with the local water table, however this was not confirmed on site. Additionally, because of the disturbed nature of the site, artificial condition of the ponds, and lack of information from which to compute volume, it was not possible to compute water balances.

There are no known public or private water uses of the ponds. They may, however, be used by the quarry operation for process needs.

Biological Conditions Of Natural Ponds: It was not possible to obtain data on aquatic vegetation in the quarry ponds on site. However, it is expected that no aquatic vegetation occurs in these ponds because of their disturbed nature.

Although there are no site specific data on aquatic invertebrates that could inhabit these ponds, it is common for numerous species of invertebrates, especially true flies, beetles, and striders to inhabit small permanent or temporary pools with low to moderate levels of diversity.

Because the ponds are isolated from natural watercourses, are not natural, and are the result of quarrying operations, it is unlikely they contain any fish. However, the ponds may supply some limited habitat for reptiles and amphibians and may act as a water source for mammals and birds.

Inland Wetlands: Wetland areas total approximately 22 acres (16 percent) of the site. Of these wetlands, approximately 6 acres occur within areas of quarrying activities.

Other wetland areas border the site to the west, and they also occur in the central portion of the site within the quarry. The western border of the site is drained by the Plymouth River, and the central portion of the site is drained by an unnamed stream that flows north generally parallel to the Plymouth River before joining it.

Wetland boundaries have been determined by review of U.S. Soil Conservation Service (Soil Conservation Service, 1987) maps, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps (undated) and aerial photography (1978). Wetlands were delineated in the field based on the presence/absence of vegetation typically adapted to life in saturated soil conditions (i.e., wetland emergent, scrub/shrub and forested vegetation). See Figure 4.25.

Although large wetland areas designated on site correspond closely with the occurrence of hydric soils (Soil Conservation Service, 1987), there are many additional smaller wetlands. Hydric soils on site include Freetown muck, Scarboro and Birdsall soils, Swansea muck, Walpole sandy loam, and extremely stony Whitman fine sandy loam. The upland soils are dominated by either disturbed areas associated with the 62-acre quarry or various rock outcrop complexes.

The wetland areas likely experience fluctuations in water levels as a result of precipitation, groundwater flow, and quarrying activities. All of the wetland areas are bordered by either historic or active quarrying activities. Aerial photographs from 1978 show different hydrologic characteristics at site than those currently present. The wetland in the northeast corner of the site appears to have had a higher water level, while several wet areas in the now active quarry area had not been quarried at the time of the photograph.

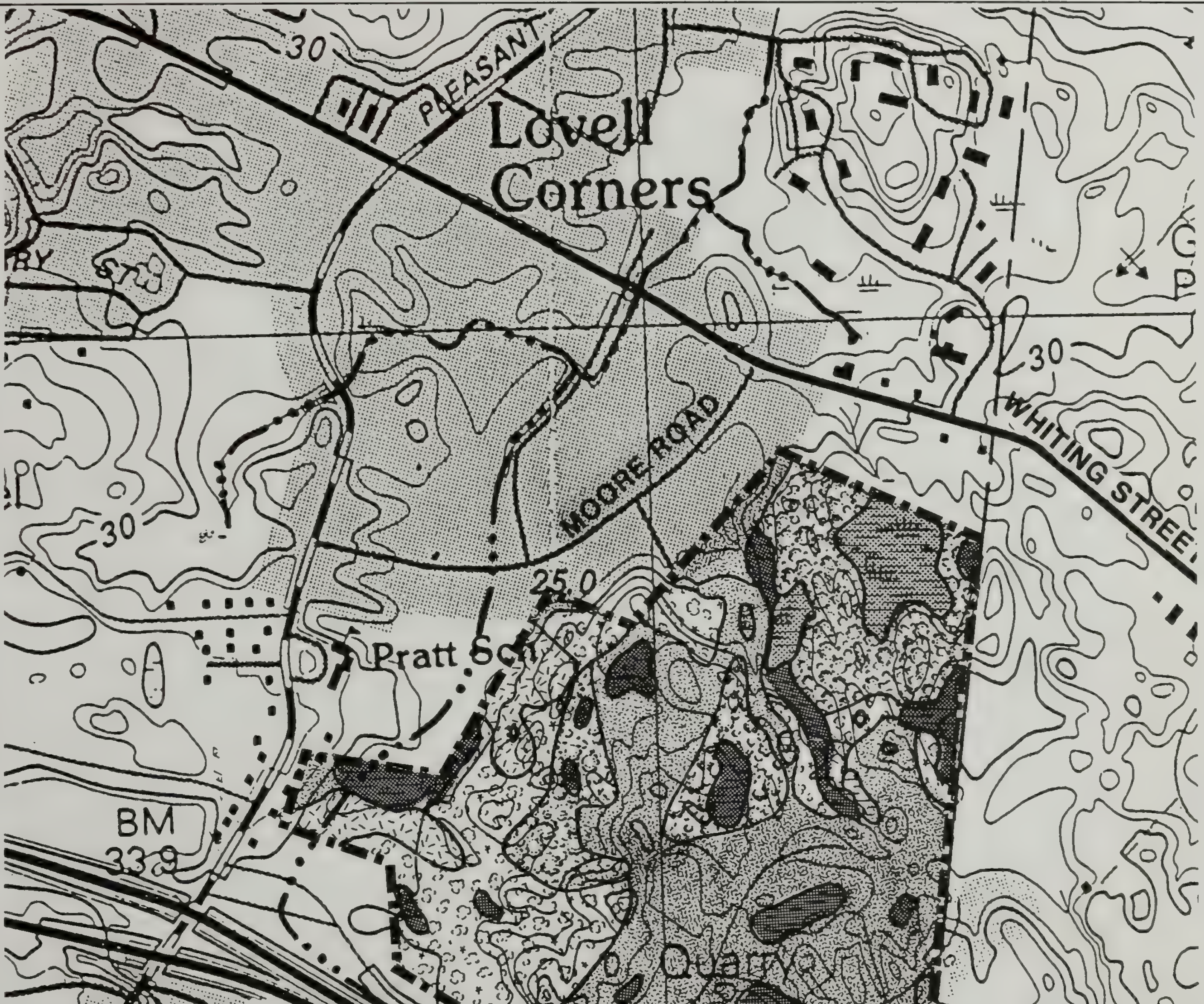
The on site wetlands are likely fed by a combination of groundwater and surface water. Depth to groundwater is shallow in several areas of the site, as evidenced by excavation activities that appear to have intercepted groundwater in some of the artificial ponds. Specific hydrodynamic studies of the wetlands have not been conducted.

Little or no standing water is present in the wetland areas, so this characteristic is not applicable.

No public or private water supplies are present in the on site wetlands.

Biological Conditions Of Inland Wetlands: Most of the wetlands on site are considered hydrologically isolated units, although several community types are present. Wetland communities as subsequently discussed include forested, scrub-shrub, and emergent areas. Several small pockets of forested wetlands are scattered throughout the area. The presence of a bog/Atlantic white cedar wetland, as described below is somewhat unusual.

Areas of forested hydrophytic vegetation occur scattered throughout the site. Some are associated with the Plymouth River and the many small tributaries to this river. Others are



SOURCE: Cortell, (March, 1990)

FIGURE

4.25 **Weymouth Vegetative Communities**

0 725 Feet

isolated either in the midst of mature forest or in the midst of the quarry. These areas are composed primarily of red maple, eastern hemlock, rough alder, white pine, arrowwood, common winterberry, tussock sedge, common highbush blueberry, cinnamon fern, and shining moss. Among the forested wetlands, the red maple swamp forest along the Plymouth River and the hemlock swamp forest at the northeastern corner of the site are most noteworthy, since they contain a large species diversity and support locally uncommon plants such as Atlantic white cedar.

Two large areas of scrub-shrub hydrophytic vegetation occur in the northeastern portion of the property and two smaller areas occur elsewhere on the site. These areas are dominated by red maple, black gum, sweet pepperbush, common highbush blueberry, water willow, sheep laurel, Canada rush, Canada mannagrass, and *sphagnum*. The scrub-shrub wetland at the northeastern corner of the site has regions that are bog-like, containing a dense *Sphagnum* mat. This wetland has an exceptionally high species diversity with locally uncommon plants, such as pod-grass and early azalea, and supports an unusual mixture of tree, shrub and herbaceous species (e.g., black gum, white pine, water willow, bayberry, switchgrass, woolgrass, and *Sphagnum*).

Many small areas of emergent hydrophtic vegetation occur in the northern half of the site. These areas are composed primarily of cespitose knotwood, common cattail, spreading bentgrass, reed grass, and wool grass. The northernmost portion of the emergent wetlands contains an unusually high diversity for its small size and supports plants that were not observed elsewhere on the site such as water plantain, steeplebush, and reed canary grass.

Although there are no site specific data on aquatic invertebrates that could inhabit these nontidal wetlands, it is common for numerous species of invertebrates, especially true flies, beetles, and striders to inhabit small permanent or temporary pools in such wetlands.

The vegetated wetlands on Weymouth are assumed to not supply any fisheries habitat.

Wildlife suitability on site is generally restricted by the gravel pit operations. The northeast and southwest corners provide the most viable wetland habitat areas.

Threatened and Endangered Species. No wildlife species on the State List of Endangered and Threatened Wildlife and Plants (321 CMR 8.00; October 16, 1986) or the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12; August 1988) were observed onsite. In addition, the Atlas of Estimated Habitat of State-Listed Rare Wetlands Wildlife (Natural Heritage and Endangered Species Program, 1989) does not indicate any suitable habitat for rare wetlands wildlife within 2 miles of the site.

4.8.4(d) East Brookfield Site

Site Description. The site in East Brookfield is located to the southwest of the intersection of Route 49 and West Main Street (Route 9) (see Figure 4.26). The volume of materials for the site has been calculated by taking into consideration the aquatic resources of the site. Approximately half of the site is located in East Brookfield and half in Spencer. Travel time from downtown Boston is approximately 1.25 hours at a distance of 66.8 miles. There is no apparent direct access into the site, although it abuts Route 49 and is in close proximity to Route 9. A Conrail right-of-way borders the southwestern edge of the site. The site is approximately 219 acres of wooded area and is undeveloped. To the northwest of the site is residential development. West Main Street, north of the site, has a mixture of low density commercial and residential development.

Aquatic Resources. Three aquatic resource areas have been identified on site: nontidal waters, natural pond, and inland wetlands.

Nontidal Waters: Nontidal waters are present on the East Brookfield site within the banks of the Sevenmile River.

The site is located in sub-basin 218 of the Chicopee Drainage and drains entirely into the Sevenmile River. The main surface water feature of this area is the Sevenmile River which flows south, parallel to the north border of the site, before it joins East Brookfield River approximately one mile southwest near the Town of East Brookfield. East Brookfield River then flows into Quabog Pond and the Quabog River one mile south of its junction with the Sevenmile River.

A survey of the bottom of the Sevenmile River was made in January 1990. The depth of the Sevenmile River channel varies from 1 to 4 feet in the reach that parallels the site, while the width varies from 20 to 50 feet. The substrate of the channel consists of sand and pebbles with very large boulders scattered along the channel. Although most of the channel was devoid of vegetation, slower moving areas in eddies contained dead leaves and other vegetative matter. The boulders serve as a substrate for periphton, while several species of aquatic plant inhabit part of the channel bottom.

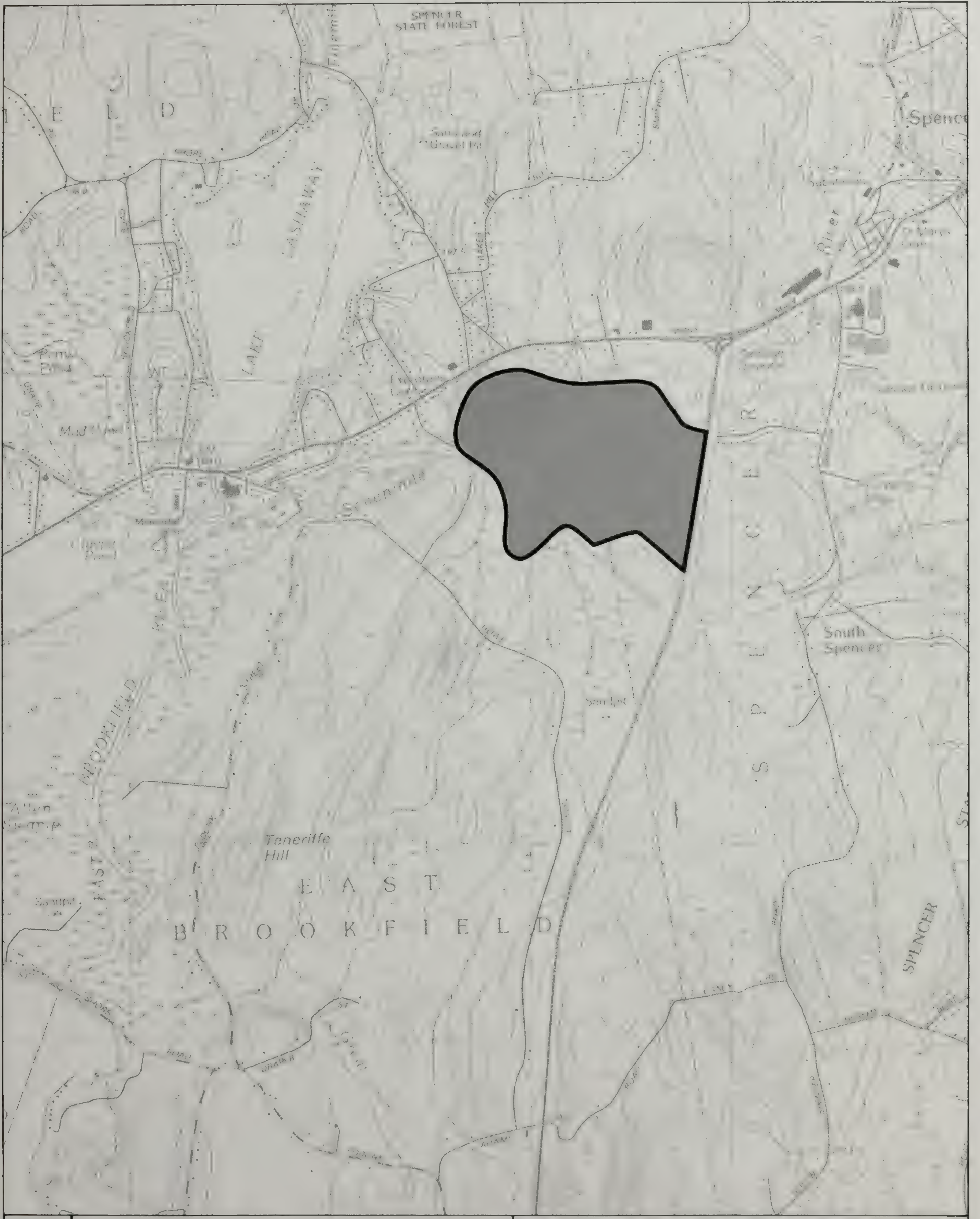
The USGS has maintained a gaging station on the Sevenmile River in Spencer since 1960 (Gage No. 01175670). The maximum discharge measured was 412 cfs on March 18, 1968, and the minimum discharge was 0.04 cfs (regulated) on September 10 and 11, 1980. The average discharge for the period of record is 14.6 cfs (1.68 cfs), or 22.84 inches per year.

The depth of the Sevenmile River channel varies from 1 to 4 feet in the reach that parallels the site, while the width varies from 20 to 50 feet. Stream velocity ranges from 0.4 to 2.0 fps.

The Sevenmile River is bounded on the south by a bank approximately 10 to 20 feet high. Flood maps (Federal Emergency Management Agency, 1981) indicate that the 100-year floodplain varies in width from 100 to 800 feet in the reach that parallels the proposed disposal site (Figure 4.27).

Chemical Characteristics Of Nontidal Wetlands: The Sevenmile River is classified by DWPC as Class B, which is to be suitable for protection and propagation of fish and other life, primary and secondary contact recreation, public water supply after appropriate treatment, and agricultural and industrial uses.

The DWPC has conducted studies on the Sevenmile River. In 1986, several samples were taken from the Sevenmile River at sites adjacent to the proposed disposal site. The dissolved oxygen concentration was 7.2 and 7.1 mg/l, which was 77 and 76 percent of saturation,



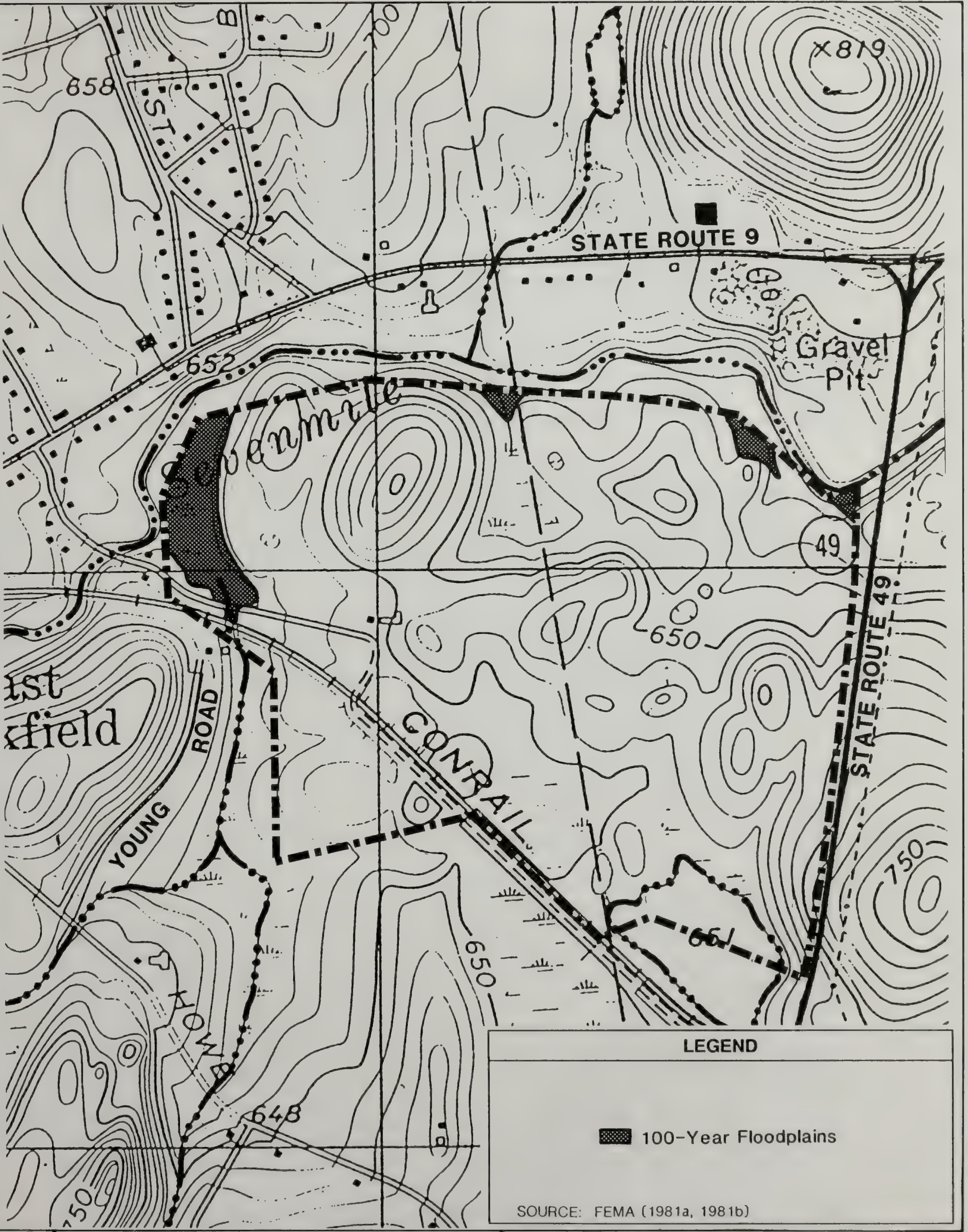
FIGURE

4.26

East Brookfield Site

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 .5 MILES



SOURCE: FEMA (1981a, 1981b)

FIGURE

4.27

East Brookfield Floodplains

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 725 Feet

respectively. Biochemical oxygen demand and nitrogen concentrations were quite low in the three River sampling stations. Hydrogen ion measurements were 5.9 to 6.3, respectively. The effluent of the Spencer Wastewater Treatment Plant, which had a flow of 0.60 MGD, had low coliform concentrations, probably because of the relatively high chlorine residual of 2.3 mg/l. Kjeldahl nitrogen was 9 mg/l, ammonia was 7 mg/l, and nitrate was 0.3 mg/l. The water quality in the Sevenmile River meets the Class B water quality standards.

Field measurements indicated relatively low turbidity levels. Information from the DWPC indicates the Sevenmile River has low concentrations of suspended solids and the data base does not suggest there are problems with suspended particulates or turbidity.

Biological Conditions Of Nontidal Waters: Two species of aquatic vegetation were observed in the Sevenmile River during January 1990. These were *Elodea candensis* and *Sparganium americanum*. *Elodea* occurred frequently in the channel of the river along the site. *Sparganium* was limited to a few small patches near the river banks in the wider portions of the river.

The Sevenmile River also was quantitatively sampled for invertebrates during January 1990 using a Surber sampler. Several species of stoneflies, mayflies, caddisflies, and other insect nymphs and larvae that are not tolerant of pollution and which require high dissolved oxygen levels and high flow velocity were present in the river. The samples were dominated by stoneflies and caddisflies.

Annually, the Massachusetts Division of Fisheries and Wildlife stocks the Sevenmile River with two to three thousand rainbow, brook, and brown trout and yellow bullheads, fallfish, common shiners, white suckers, long and black nose dace, and the tesselated darter.

Wildlife diversity and abundance within the small, intermittent streams on site is moderate. The waterways provide habitat for small amphibians and reptiles, as well as feeding and watering areas for mammals and birds. The generally undisturbed nature of the area increases its habitat value. However, the limited areas of ponded areas restricts suitability for waterfowl. The Sevenmile River, however, provides habitat for similar species, and diverse habitat that can support more wildlife species.

Public And Private Uses Of Nontidal Wetlands: Groundwater at the site occurs at greater depths at the higher elevations but becomes shallower with closer proximity to the Sevenmile River and wetland areas. The USGS has mapped the site and surrounding areas on the basis of groundwater favorability (Cederstrom and Hodges, 1967). The majority of the site (75 percent) is classified as containing water-bearing units consisting of stratified glacial drift, glacial till, and bedrock. These units are probably favorable for the development of domestic and municipal groundwater supplies. Wells installed along the banks of the Sevenmile River would probably yield the greatest quantities of groundwater from the sand and gravel deposits. Fractures within the underlying bedrock could also yield groundwater if a sufficient number of fractures are intersected by a well. Upland areas of the site underlain by glacial stratified deposits provide good groundwater recharge potential for wells, wetlands, streams, and the Sevenmile River. The remaining 25 percent of the site, the southeastern corner, is classified as containing non-water-bearing units.

While water is not supplied from wells immediately adjacent to the proposed site, East Brookfield has three wells located within 100 yards of the banks of the East Brookfield

River, approximately 1.6 miles downstream of the disposal site. Limited data available from the drilling reports indicate very high water quality from these wells. The data indicate a potential yield of 800 gpm although the needs of the town were projected to be far below that volume. A well study completed in 1989 (Maher, 1989) indicates that the original well is producing water with higher iron and manganese concentrations at greater depths in the aquifer. A new well was sited near the existing 8-inch well in 1989. The well is 12 inches in diameter and screens a shallower depth of the aquifer to avoid drawing water with high iron or manganese content. The well study recommended pumping at a maximum rate of 150 gpm.

During the 1989 study, the Zone II of the well was calculated (Maher, 1989). This zone delineates the zone of contribution to the well based upon 180 days of no recharge and a 0.1-foot drawdown level. The proposed disposal site is outside of this zone. However, another area termed the Extended Zone II was also calculated. It extends from the Zone II upstream along the border of the East Brookfield River. Based upon groundwater time of travel, it may receive waterflow from the site.

Natural Pond: As illustrated in Figure 4.27, a 13-acre natural pond is located on the southeast corner of the East Brookfield site. The pond was examined in January 1990 and although the ground was snow covered and the pond iced-over, some descriptive information was obtained. The portion of the pond that occurs on site totals 7 acres or approximately 3 percent of the site. The pond has a drainage area of 15.6 acres. With an average annual flow of 1.68 cfs, as measured at the USGS gaging station in Spencer, the pond could have a discharge rate of 0.04 cfs.

The pond is shallow and has numerous stumps. Although no specific information is available, it is reasonable to conclude that the bottom is composed of an organic muck typical of this habitat type.

While there are no bathymetric data, assuming the pond has an average depth of 4 feet, the pond has a volume of approximately 2.7 million cubic feet and an average annual flushing rate of 2.2 years.

Federal Emergency Management Agency (1981a and 1981b maps) indicate no floodplains adjacent to the pond.

Chemical Characteristics Of Natural Pond: The pond is classified by DWPC as Class B which is to be suitable for protection and propagation of fish and other life, primary and secondary contact recreation, public water supply after appropriate treatment, and agricultural and industrial uses.

The only water quality data that are available are those that were obtained in January 1990. Samples collected from the pond and its outlet stream indicated a dissolved oxygen concentration at 57 percent of saturation. This is relatively low and is most likely the result of a high oxygen demand under the ice from sediments and decaying plant materials. Ice prevents atmospheric aeration and decaying matter continues to utilize oxygen with no source of replenishment. This in turn causes low oxygen concentrations and is particularly common in shallow eutrophic bodies of water. The 7.7 mg/l dissolved oxygen concentration was within Class B water quality standards. The hydrogen ion concentration was within the acceptable range for Class B water. Turbidity was also low and showed no evidence of severe coloration from humic materials.

There are no reported public or private water uses of the pond. However, there are a number of downstream municipal water supply wells.

Biological Conditions Of Natural Pond: The pond is known to contain a large standing crop of submerged aquatic vegetation during the summer months. There is no available information, however, on the species that may inhabit the pond.

There is no information on the aquatic macroinvertebrate community. It is reasonable to assume that a warm-water fishery is present and utilized by wildlife for food.

As with the nontidal waters on site, the pond likely provides habitat for amphibians and reptiles. Additionally, the shallow water likely provides an attractive resting and/or feeding location for waterfowl.

Although rare wildlife species habitat has been identified nearby, that habitat is not similar to the pond discussed above.

Inland Wetlands: Wetland areas total approximately 59 acres (27 percent) of the site. These boundaries were determined by review of U.S. Soil Conservation Service (Soil Conservation Service, 1985) maps, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps (undated), as well as aerial photography (1980). Wetlands were delineated by Jason M. Cortell and Associates Inc. in the field based on the presence/absence of vegetation typically adapted to life in saturated soil conditions (i.e., wetland emergent, scrub/shrub, and forested vegetation). See Figure 4.28.

Areas on site designated as wetlands are more extensive than areas of hydric soils (Soil Conservation Service, 1985). Hydric soils on site include Freetown muck, Scarboro fine sandy loam, Swansea muck, and Rippowam fine sandy loam. The majority of the upland areas consist of the Chatfield-Hollis Rock Outcrop Complex on the four hilltops and the Paxton series in the lower areas.

All of the wetlands onsite discharge to the Sevenmile River or its tributaries. The emergent and scrub/shrub wetland located in the north central portion of the site, however, appears to occur in a depression which does not have a defined outlet. The emergent portion of this wetland, as well as the emergent wetland which occurs along the railroad had standing water during field investigations.

Biological Conditions Of Inland Wetlands: Upland community types on the property consist of mature and successional forests and early successional fields. One small isolated wetland occurs in the north central part of the property and the remaining wetlands drain either directly or indirectly to the Sevenmile River. Several wetland community types are present, as subsequently discussed, and include forested, scrub-shrub, and emergent areas.

Wetlands on site are not unusual or unique to this area. A diverse wetland community is located to the east across Route 49, along the Cranberry River. Additionally, a large forested and scrub/shrub complex occurs to the south of the railroad tracks.

Mature upland forest communities are located throughout the site, except for the extreme western portion. These communities are dominated by white oak, red oak, sheep laurel, common highbush blueberry, ground pine, and wintergreen. Eastern hemlock predominates on the steep slopes in the north central part of the property.

Successional or disturbed upland forest communities are scattered throughout the central portion of the property. These communities are dominated by gray birch, hawthorn, bigtooth aspen, black cherry, staghorn sumac, alleghany blackberry, Canada goldenrod, and bracken fern.

Early successional upland fields are also scattered throughout the site. These successional communities are dominated by fairy aster, Queen Anne's lace, Virginia peppergrass, pineweed, Canada goldenrod, common mullein, and bouncing Bet. The area along the Conrail railroad tracks supports mainly grasses and large fields found in the western part of the site that were apparently planted with corn at one time and have now undergone succession to weedy herbaceous species.

Areas of forested hydrophytic vegetation are scattered throughout the site and are primarily associated with Sevenmile River and several of its tributaries. These areas are composed primarily of red maple, silky dogwood, common winterberry, white pine, eastern hemlock, common highbush blueberry, arrowwood, golden threads, tussock sedge, sensitive fern, cinnamon fern, and sphagnum.

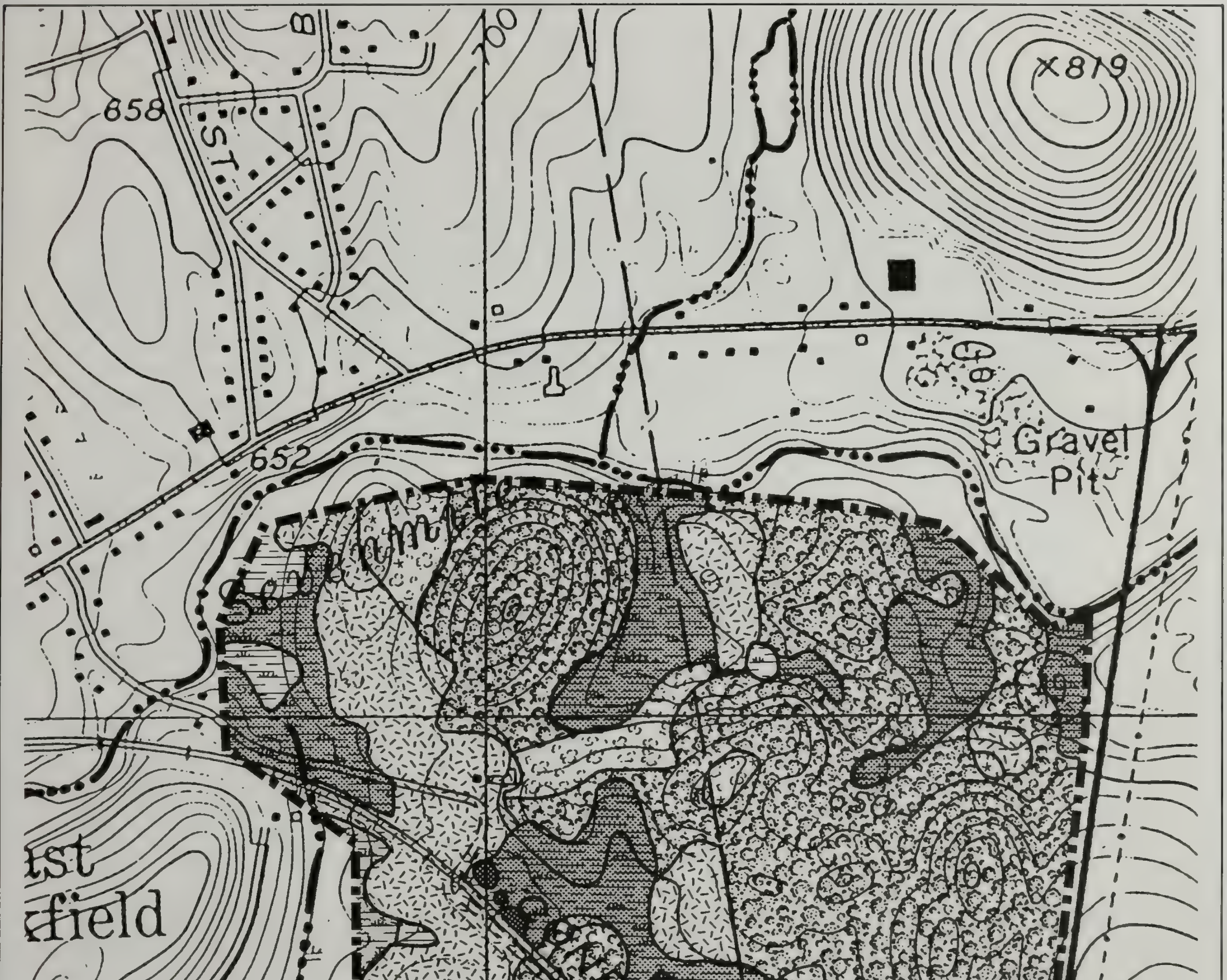
Three areas of scrub-shrub hydrophytic vegetation occur along the southern periphery of the property. One area is associated with a tributary of Sevenmile River, and another is associated with the large natural pond in the southeastern corner of the site. These areas are dominated by rough alder, silky dogwood, American elm, steeplebush, meadowsweet, tussock sedge, wool grass, sphagnum, and sensitive fern.

One isolated area of emergent hydrophytic vegetation occurs in the north central part of the site. Additionally, several emergent areas occur adjacent to the floodplain forest of the Sevenmile River along the western border of the site. Three of these four latter areas occur in abandoned corn fields, which have undergone succession primarily to obligate and facultative wetland herbaceous species. In total, emergent areas are composed primarily of northern willow-herb, common cattail, blue vervain, soft rush, and wool grass.

No site specific invertebrate sampling has been done within the East Brookfield wetlands.

The vegetated wetlands on East Brookfield are assumed to not supply any fisheries habitat. Waters of Sevenmile River and the natural pond, which do supply fisheries habitat, do not appear to frequently exceed the banks. Therefore, fish species cannot normally occur in the vegetated wetlands.

Wildlife diversity and abundance on site is largely determined by the availability of a diverse habitat. The relatively large size of the property, its generally undisturbed nature, and the proximity of additional habitat lands, enhances the suitability of the property for wildlife. The wetlands on site support a vegetative interspersion that is likely reflected in an increased wildlife diversity. Agricultural fields may serve as a source of wildlife food in addition to that supplied by natural vegetation. The presence of open water supplies both lentic and lotic habitat, particularly the pond located in the southeast corner and the Sevenmile River just north of the property. Few wildlife species



SOURCE: Cortell (March, 1990)

FIGURE

4.28 **East Brookfield Vegetative Communities**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 725 Feet

were observed on site, most likely because of the time of year. Wildlife signs, however, were numerous and included deer, squirrel, and beaver.

Threatened and Endangered Species. No wildlife species on the State List of Endangered and Threatened Wildlife and Plants (321 CMR 8.00; October 16, 1986) or the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12; August 1988) were observed on site. The Atlas of Estimated Habitat of State-Listed Rare Wetlands Wildlife (Natural Heritage and Endangered Species Program, 1989), however, indicates that suitable habitat for rare wetlands wildlife occurs about 0.1 mile from the southwest corner of the site. The habitat type is not identified, however, so it is not possible to evaluate the possibility of additional habitat at the East Brookfield site.

4.8.4(e) Governors Island Flats

Site Description. This site is located in a shallow area of the Harbor, bounded by Logan Airport to the north and President Roads and the Main Ship Channel to the south and west (see Figure 4.29). Approximately 25 percent of this area consists of tidal flats, while the remainder ranges in depth from one foot below MLW to 27 feet below MLW. The site is located about three hours from the marine transfer stations by barge.

Based on the NOAA Navigation Chart and aerial photographs, Governors Island Flats contain 24 acres of saltmarsh and approximately 105 acres of intertidal mudflats with shellfish. This area was calculated from a 1984 aerial photograph and field verified in June 1987 by Jason M. Cortell and Associates. The 24 acres represents the area within the bulkhead line defining the limits of construction into the Harbor. The site is now vacant and is zoned as waterfront industrial.

Aquatic Resources. Three aquatic resources have been identified for this site: tidal waters, coastal mudflats, and coastal wetlands.

Tidal Waters: Tidal waters are found along the entire eastern and southern shoreline of the Governors Island site. Recreational boating and fishing take place within this resource area.

The substrate at Governors Island ranges from a coarse muddy gravel to soft organic mud and silt. While there are no chemical data available for the site specifically, bulk sediment analyses have been conducted on sediment off the end of Runway 33L and may be representative of local conditions. The sediments which have been described as grey and black oily fine to medium sand were within the range for Category I sediments and are not considered contaminated.

Water quality data indicates that suspended solids near Governors Island Flats in 1986 had a range from 12 to 32 mg/l. As with other exposed and shallow parts of the Harbor, wind generated waves and wastewater outfalls influence the level of suspended materials and turbidity in the area. The site is approximately 2.7 miles from the Deer Island outfall. The levels of suspended materials, however, do not appear to have an impact on the biological productivity of the area.

NOAA Tidal Current Charts indicate moderate current velocities at the eastern and western ends of the area, ranging from 0.17 to 1.0 feet per second (fps). The direction of the tidal currents is variable from northwest to southeast. As with all of Boston Harbor, the average tidal range in the vicinity of Governors Island is 9.6 feet, with spring tides averaging 14.5 feet.

Wave energies at Governors Island Flats are moderate to strong. A wave energy study conducted at Runway 33-L (directly north of Governors Island Flats) shows that breakers could be a minimum of 4.4 feet in height during southeast storm conditions.

Groundwater interaction is limited. Because the landward part of the site consists of the runways and taxiways of Logan Airport, there is a large percentage of impervious materials. Additionally, the airfield itself has been constructed on hydraulic silts and clays which are relatively impervious. Infiltration is also minimized by the extensive storm water sewer system on the airfield. These physical factors combine to greatly limit the extent of groundwater interaction at Governors Island Flats.

Chemical Characteristics Of Tidal Waters: Water quality in the vicinity of the Governors Island Flats is classified as SB. Water quality conditions adjacent to this area were studied in 1986. With the exception of excessive bacteria concentrations at times, water quality parameters meet applicable Class SB standards.

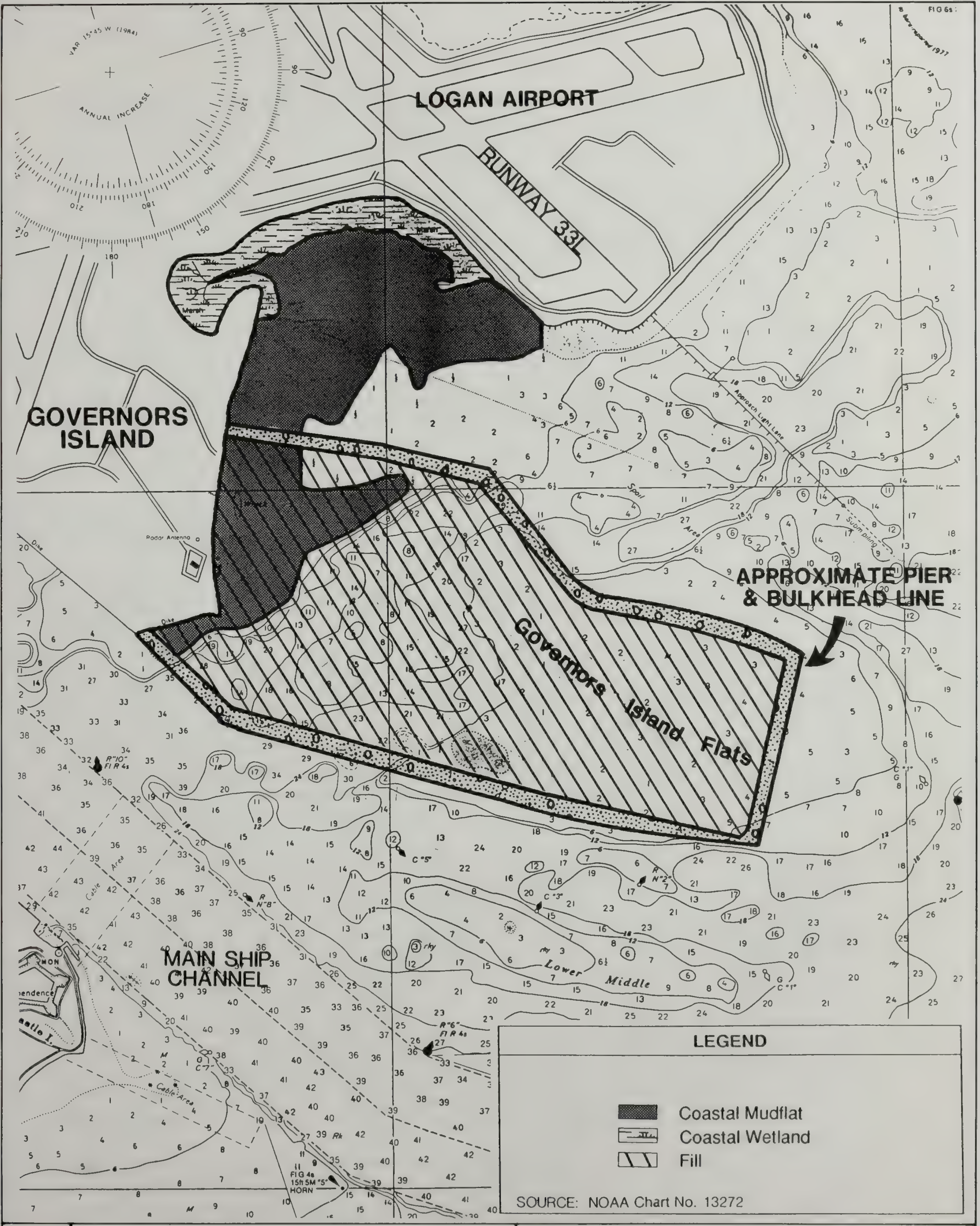
Salinity at the site is saline with variations being caused by wastewater discharges and runoff from the airfield and other urban areas. There are no nearby thermal inputs that would cause unnatural variations in temperature.

Biological Conditions Of Tidal Waters: No rooted marine plants such as eel grass and/or widgeon grass have been observed in the area. However, a number of drifting species of green and brown marine algae have been seen in the area. With the exception of the beach protection riprap, the site has very little hard substrate for the growth of attached forms of marine algae.

While under contract to the Massachusetts Port Authority, the New England Aquarium and Battelle New England Marine Laboratory sampled the benthic community at the end of Runway 33-L during October 1982 and August to September 1983 (Massachusetts Port Authority, 1989). The sampling locations are on the edge of Governors Island Flats and approximately 1,600 feet from the site. During 1982, the Shannon Weiner species diversity was 0.84 (S=22) and during 1983 it was 2.9 (S=39). In contrast to the benthic community at Runway 22-L, species diversity increased with increasing water depth. Overall, the benthic community was dominated by pollution tolerant worms, including the spionids *Streblospio benedicti* and *Polydora ligni*.

There is a diverse fish community in the Harbor. Some species are transients and others are permanent. Because of the large area of tidal waters and large contact with surrounding tidal waters, it is reasonable to assume that the site is utilized by neritic and demersal fish species during parts of the tide cycle.

Mammal diversity and abundance in the vicinity of Governors Island is limited. Terrestrial mammals found in the vicinity include the norway rat and the cottontail rabbit. Species of



SOURCE: NOAA Chart No. 13272

FIGURE 4.29 Governors Island Flats

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 1115 Feet

marine mammals which may occur in the tidal waters, although their presence is uncommon in the Harbor, include harbor seals (*Phoca vitulina*), harbor porpoises (*Phocena phocena*), and grampuses (*Grampus griseus*) (Fiorelli, 1982).

Bird species which have been observed in the vicinity of Governors Island, both on upland and aquatic portions include the snowy owl, black duck, mallard, herring gull, least sandpiper, common tern, double crested cormorant, red-winged blackbird and killdeer. Observed diversity and abundance of waterfowl at Governors Island is somewhat limited by adjacent airport activities.

Public and Private Uses Of Tidal Waters: There are no public or private water supplies on or in the vicinity of the Governors Island site.

Coastal Mudflats: Coastal mudflats occupy approximately 105 acres of the Governors Island Flats. The substrate at Governors Island flats ranges from a coarse muddy gravel to soft organic mud and silt. One area of clean sand has developed at a beach protection groin along Runway 9/27. The beaches are well protected from erosion by large riprap.

Biological Conditions Of Tidal Waters: There are no known stands of marine vegetation such as eel grass and widgeon grass at the Governors Island site.

Fish undoubtedly use the mudflats during parts of the tide cycle for forage. The fish would include neritic and demersal species such as killfish, silversides, flounder, and carnivores.

The mudflats are productive shellfish harvesting areas. They are open to commercial shellfish harvesting by Master Diggers. During June 1987, the shellfish beds were sampled at 20 locations. An average of less than one softshell clam per cubic foot was found (range 0 to 5 per square foot) with 67 percent being seed class and 33 percent of legal size. No intermediate sizes were found. Although of relatively low density, DEP and DMF report that the beds quickly repopulate after several seasons of rest. Blue mussel beds were observed in the area with 10 to 15 percent containing live organisms.

Coastal Wetlands: The Governors Island Flats include approximately 24 acres of low salt marsh located between tidal flats on its seaward side and rocky banks on the inland side. The marsh vegetation does not extend beyond the perimeter of the Island. Several small tidal creeks drain through the salt marsh, particularly in the western portion. Typical salt marsh peat is the likely salt marsh substrate. The salt marsh is tidally influenced by the adjacent open waters.

Biological Conditions Of Coastal Wetlands: The marsh is dominated by salt marsh cordgrass, with other minor species such as salt meadow cordgrass and glasswort also present. Small patches of reed grass occur along the upland edge of the salt marsh. The upland vegetation on Governors Island is disturbed, consisting of grasses, evening primrose, goldenrods, mullein, hawkweed, clover, yarrow, sweet fern, and other species.

A survey of Governors Island made by Jason M. Cortell and Associates Inc. in 1975 indicated the biomass of this salt marsh to be 1,080 to 1,360 g/m^2 (dry weight). This compares favorably with salt marsh biomass recorded elsewhere. Therefore, this salt marsh is likely a substantial source of food and cover for local wildlife and invertebrate species, as well as fisheries.

No sampling of aquatic invertebrates has been conducted within the salt marsh. It is assumed that a pollution tolerant population typical of salt march areas in Boston Harbor is present.

Fish likely make use of the tidal creeks within the salt marsh during parts of the tide cycle.

The presence of the flats and tidal creeks increases the suitablity of the marsh as a feeding ground for various birds, despite the noise from the adjacent runways. Bird species observed in the salt marsh include herring gull, mallard, killdeer, red-winged blackbird, least sandpiper, and common tern.

4.8.4(f) Hull Bay

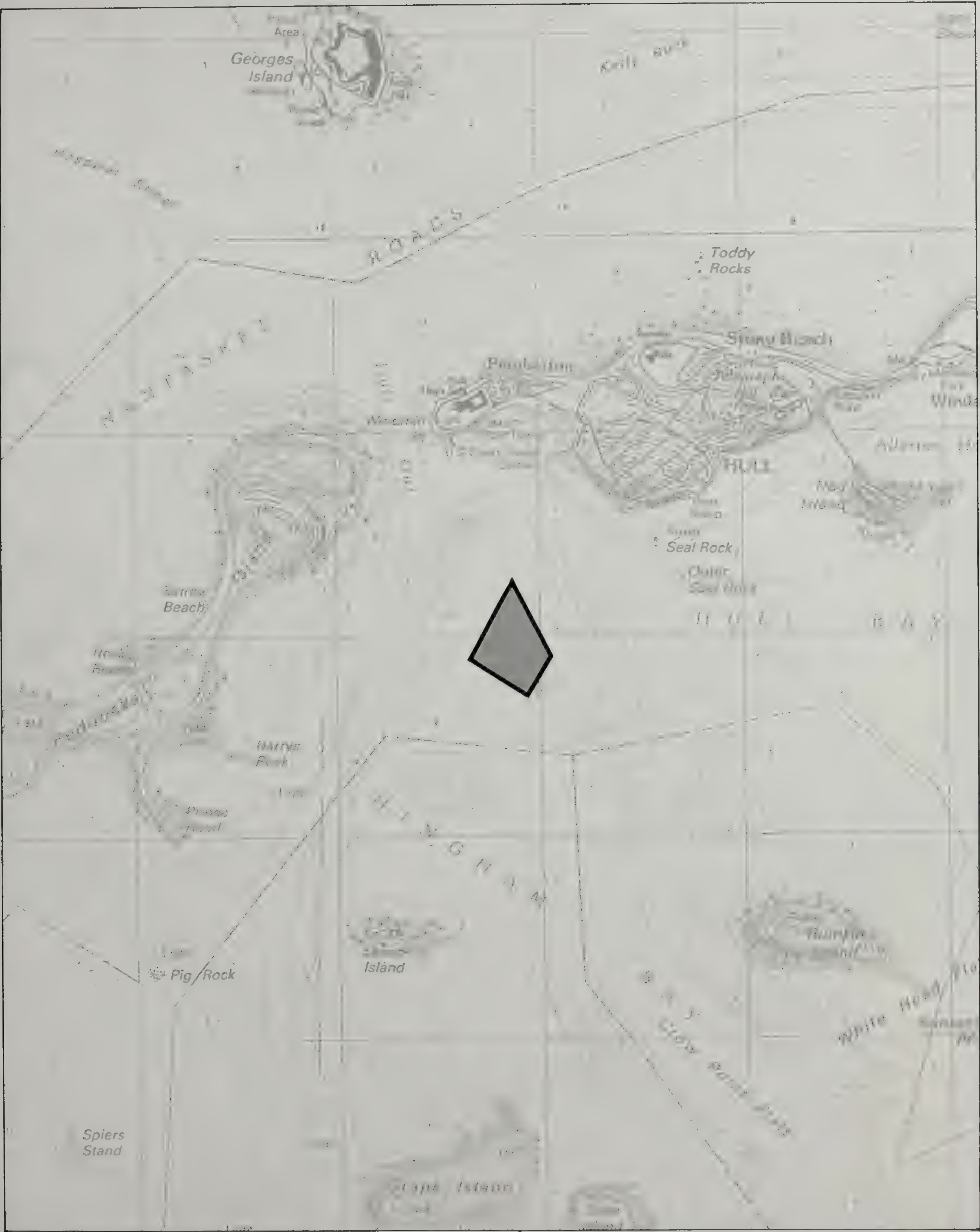
Site Description. The Hull Bay disposal area is located approximately 1,000 yards south of Windmill Point, which is at the northwestern extremity of Hull (see Figure 4.30). The site is approximately 500 acres in area. Depth soundings taken in this area show water depths of 70 feet below mean low water (MLW). The Hull Bay disposal area has previously been used for dumping, but it is now inactive. The site is located about 3 hours by barge from marine transfer stations in Boston. The site is adjacent to islands included in Boston Harbor Islands State Park. The one aquatic resource at this site is tidal water.

Aquatic Resources.
Tidal Waters: Bottom sediment samples taken from this area show a range in particle size from silty sand to cobbles, indicating a relatively high energy environment. While there are no bulk chemical data from the site specifically, the MDWPC sampled a site approximately 3,300 feet northwest of the site near Peddocks Island in approximately 20 feet of water on October 21, 1986. While not necessarily indicative of conditions at the disposal site itself, the DWPC sediment data indicates the sediments have concentrations of chromium, lead, and mercury in the Category II range.

Depth soundings taken in this area show water depths of -60 feet at mean low water (mlw) and waters of less than -30 feet within 500 feet of the site boundary (see Figure 4.31).

The Boston Harbor Tidal Current Charts (NOAA 1974) and current measurements indicate the nature of the currents at Hull Gut. The maximum surface (10 foot depth) velocity at the site is 2.0 feet per second (fps) and the average is 0.8 fps. At a depth of 25 feet currents have an average velocity of 0.6 fps and a maximum of 2.0 fps. The direction of the flood tide currents is south-southeast toward Hingham Harbor and to the north-northwest toward Peddocks Island and Hull Gut on the ebb tide. The current meter data and those from the physical sediment examinations clearly indicate that the Hull disposal site is a high tidal energy dispersal area rather than a containment site.

Tide elevation fluctuations are the same as the remainder of the Harbor, averaging 9.5 feet. There is no interaction with groundwater at the Hull disposal site.



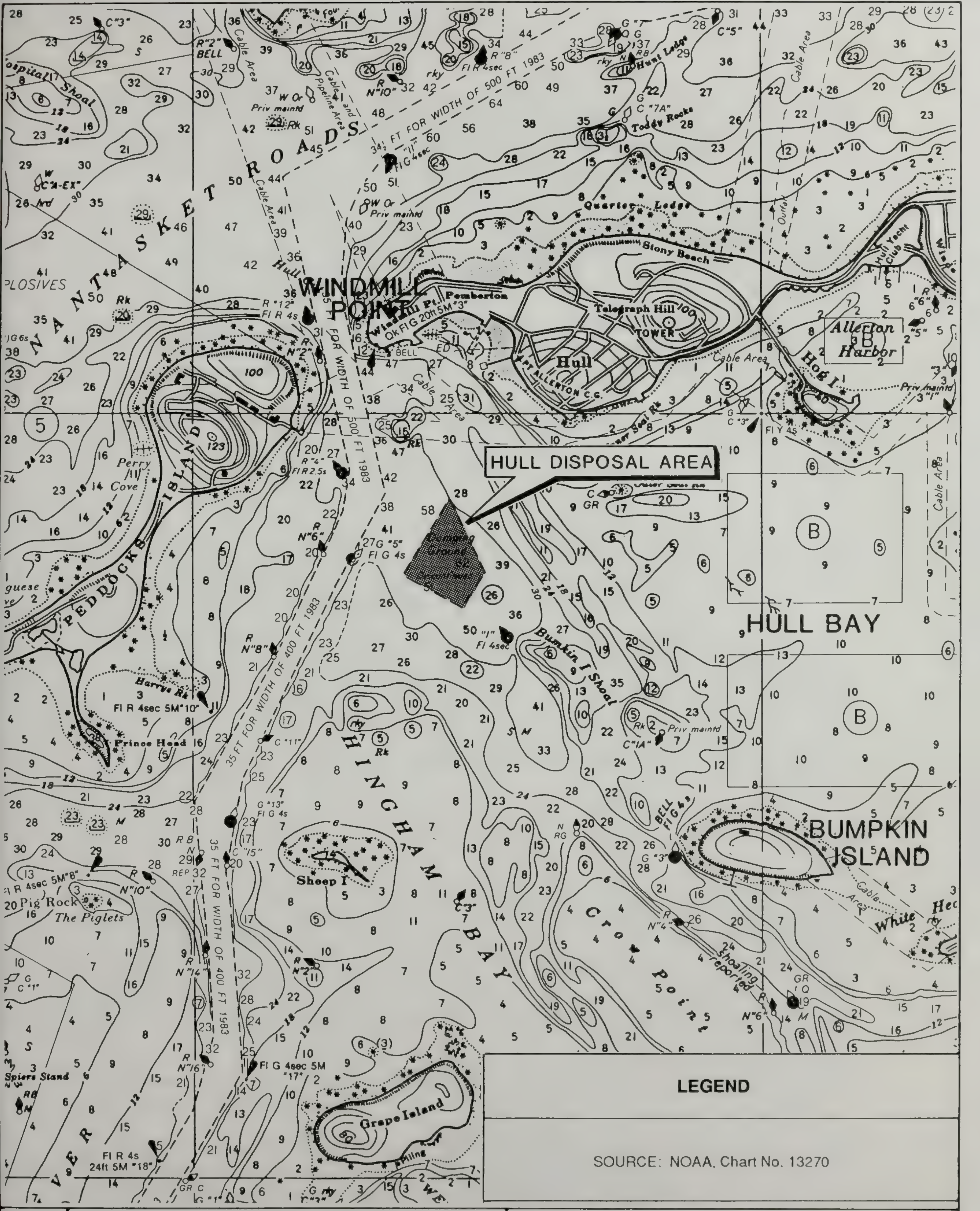
FIGURE

4.30

Hull Bay Disposal Area

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 .5 MILES



LEGEND

SOURCE: NOAA, Chart No. 13270

FIGURE

4.31

Hull Site Location Map

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
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SUPPLEMENTAL EIS/R

Chemical Characteristics Of Tidal Waters: Data from the DWPC suggest relatively low levels of suspended solids in the water of Hingham Bay. The reported 4.2 mg/l is a low concentration. Increased water column particulates can be expected during storms as wind generated waves and currents induce suspension of bottom sediments.

The DWPC has classified water at the Hull disposal site as Class SB. Water quality data indicate the water at the Hull site meets the applicable water quality standards. The waters are well oxygenated, have low bacteria, and have full strength sea water. Natural water temperatures prevail.

Biological Conditions Of Tidal Waters: The Hull Disposal Site does not contain any species of vascular vegetation such as eel grass and/or widgeon grass. Saltmarsh wetlands are present in areas peripheral to the site, but more than half a mile distant.

Hingham Bay is an important recreational and commercial fishery for many species of fish including winter and yellowtail flounder. There are no shellfish resources at the Hull Disposal site. Soft-shelled clam flats are present in many intertidal areas around the site.

Mammal diversity and abundance in the vicinity of the Hull disposal site is limited. Species of marine mammals which may occur in the tidal waters, although their presence is uncommon in the Harbor, include harbor seals (*Phoca vitulina*), harbor porpoises (*Phocena phocena*), and grampuses (*Grampus griseus*) (Fiorelli, 1982).

No direct observations for avian use of the site have been made. However, it is reasonable to assume that some waterfowl do use the area for resting and/or feeding, although the lack of tidal flats restricts the availability of food. In general, the lack of habitat diversity restricts avian abundance and diversity.

Public And Private Uses: No public and private water supply uses are present at the Hull site.

4.8.4(g) Logan Airport North

Site Description. This site is a marine underwater borrow pit and is located off the northern edge of Logan Airport (see Figure 4.32) immediately adjacent to Runway 22L. Constitution Beach is to the northwest, a residential area of East Boston is to the north, and Winthrop is to the east. Marine charts show that the maximum depth of this area is 29 feet below mean low water. Depth soundings performed in 1987 generally confirm this information. The area was created by hydraulic dredging during the expansion of Logan Airport.

The site is located 2.2 miles from the East Boston excavation site by truck and 3 hours from marine transfer stations by barge.

Aquatic resource areas found at the Logan North site are Tidal Waters. Coastal Mudflats and Coastal Wetlands occur in the immediate vicinity. Because the mudflats and wetlands may be indirectly affected by activities at Logan North, they are also described below.

Aquatic Resources.

Tidal Waters: Bottom sediments at this site are composed of approximately 1.5 feet of organic oily silt with fine to medium sand. Chemical analyses indicate the sediments are Category I quality with the exception of arsenic and oil and grease which are in the Category II range (Massachusetts Port Authority, 1989).

Between April 9 and 15, 1971, the Massachusetts Port Authority deployed current meters in the area (see Figure 4.33). The instruments recorded an average maximum tidal current velocity of 0.46 feet per second (fps) and a mean velocity of 0.29 fps. The narrow channel leading to the Logan North site between Winthrop and Runway 22L has an average maximum tidal current velocity of 1.26 fps. The area has a tidal flushing rate of 1.86 tidal cycles.

There is a limited fetch in this area, so projected wave heights during a storm with sustained winds of 50 knots (which is equivalent to the 75 year event) are estimated to be only 1.4 feet.

The extent of groundwater interaction at the site is not known. However, given the extent of development of Winthrop and East Boston and high percentage of impervious surfaces, it is reasonable to assume that the interaction is minimal.

Chemical Characteristics Of Tidal Waters: The water in the vicinity of Logan Airport is classified by the DWPC as SB. Such waters are defined as suitable for primary and secondary contact recreation, protection and propagation of marine life and wildlife, and shellfish harvesting by Master Diggers (i.e., with depuration).

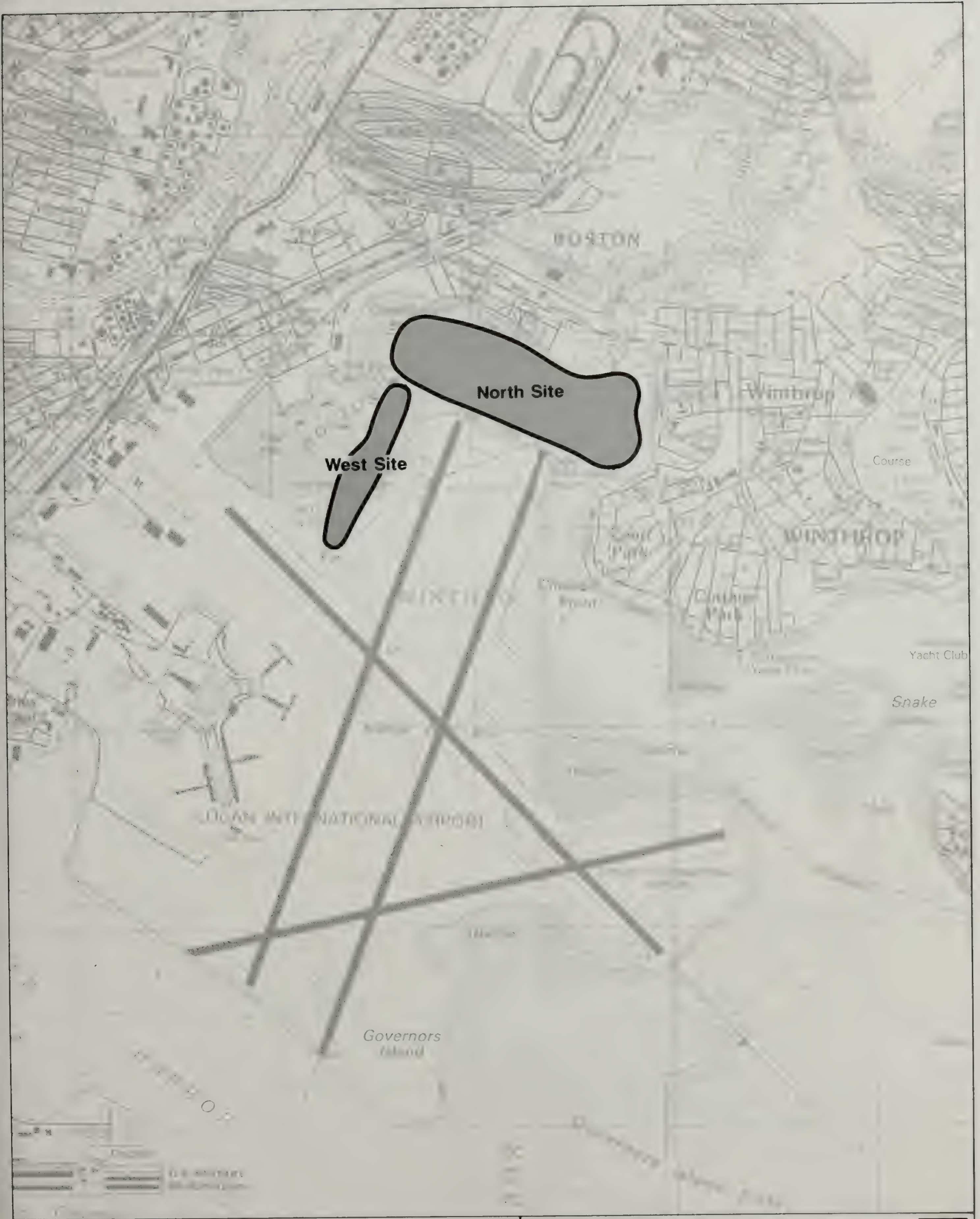
Water quality data indicate total suspended solids range from 12 to 40 mg/l. Wind generated currents, runoff, and combined sewer overflows are principal contributors of the suspended materials. Secchi disc visibility has been recorded at 6 feet.

Data from the DWPC indicate dissolved oxygen is below the minimum of 6.0 mg/l approximately 20 percent of the time, and total coliform bacteria exceeded the maximum of 700 per 100 milliliters 8 percent of the time. Other parameters, including metals, oil and grease, nitrogen, and suspended solids were within applicable water quality standards.

Recent information from the MWRA indicates that the principal source of bacteria is a storm sewer which discharges across Constitution Beach. Bacteria inputs from a CSO discharge south of Constitution Beach have been dramatically reduced as a result of screening and chlorination of overflows.

Biological Conditions Of Tidal Waters: Under contract to the Massachusetts Port Authority, the New England Aquarium and Battelle New England Marine Research Laboratory collected 30 samples of the benthic community during October 1982 and August - September 1983 at the end of Runway 22L (Massachusetts Port Authority, 1989). Pollution tolerant worms were dominant. These included the spionids *Streblospio benedicti* and *Polydora ligni*, and nematodes. The studies reported 24 and 20 species of benthic organisms, respectively.

Diversity of the benthic community was highest in shallower water and decreased as water depth increased. The Shannon Weiner diversity indices ranged from 0.85 to 2.70. According



FIGURE

4.32

Logan Airport North And West Sites

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

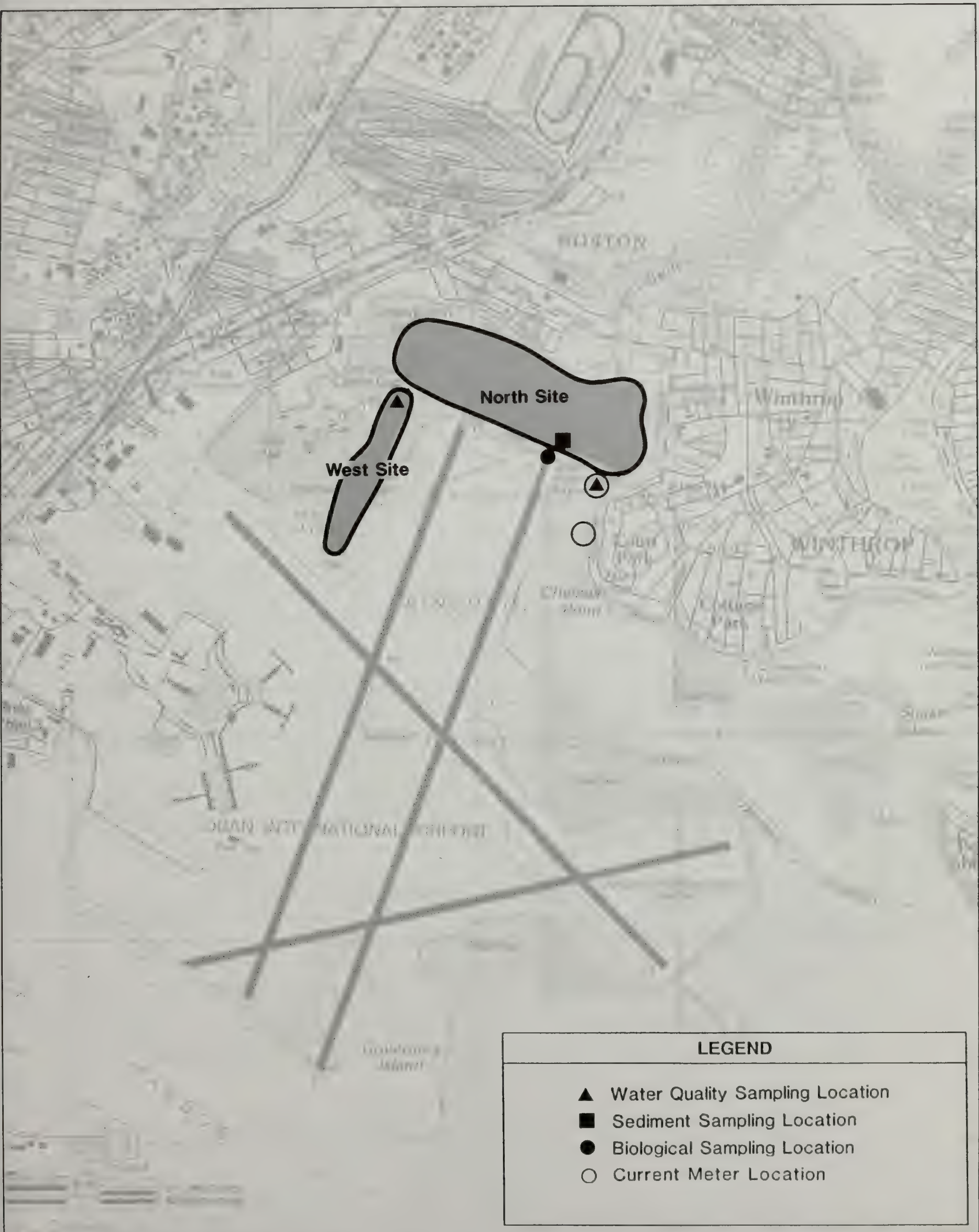

BOSTON
North Site
West Site
Winthrop
WINTHROP
LEGEND
▲ Water Quality Sampling Location
■ Sediment Sampling Location
● Biological Sampling Location
○ Current Meter Location

FIGURE 4.33

Logan Airport North And West Sites - Sediment, Water Quality And Biological Sampling Locations

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 .5 MILES

to Wilhm and Dorris (1968), Shannon diversity values of less than one are indicative of heavy pollution, values of 1 to 3 are indicative of moderate pollution, and higher values indicate little to no contamination.

While there are no site specific data on fisheries in the site, it is reasonable to assume that many of the fish reported in Boston Harbor are present at this site. The water column contains adequate dissolved oxygen for fish.

The tidal waters do not support a shellfish population. However, the adjacent mudflats do support a population of shellfish.

No site specific wildlife observations have been made within the site area. However, it is likely that marine mammals and waterfowl occur at Logan North.

No marine vegetation such as eel grass and/or widgeon grass has been found in the area. Common species of marine algae have been observed.

Public And Private Uses Of Tidal Waters: Swimming and boating at Constitution Beach are water uses at this evaluation site.

Coastal Mudflats: Coastal mudflats are found around the Logan North evaluation site. Along the Logan Airport boundary and the Winthrop shoreline they are composed of a mixture of mud/silty sand and gravel. Constitution Beach and intertidal areas along the west and north shores are composed of sand.

Biological Conditions Of Coastal Mudflats: The marine vegetative resources in the tidal mudflats have been examined around Logan Airport. No eel grass or widgeon grass has been found. There is no additional information on marine vegetation for the remainder of the mudflats.

Fish undoubtedly use the mudflats during parts of the tide cycle for forage. The fish would include neritic and demersal species such as killifish, silversides, flounder, and piscivores.

The tidal mudflats around the Logan North evaluation site contain shellfish resources. While the Massachusetts Division of Marine Fisheries has mapped the entire periphery as a shellfish resource, only the area off Runway 22L has been examined to any extent. Shellfish density at this location was surveyed during November 1986. During this period the intertidal areas north of Runway 22L contained 1.4 legal size clams per cf. In relation to other shellfish beds in the Harbor, this is below the average density although it can still be considered a commercial resource. No seed clams were present, and very few intermediate size clams were observed. In addition to live clams, many dead and decaying clams were observed.

Mammalian use of the mudflats is unlikely. Although no site specific observations have occurred, shore birds likely feed on the mudflats during low tide.

Coastal Wetlands: Coastal wetlands in the vicinity of Logan North are comprised of saltmarshes dominated primarily by *Spartina alterniflora*, although areas of high marsh, dominated by *Spartina patens*, are present as well. These salt marshes occur as either a narrow band along Logan Airport or as a small estuary located to the southeast of the disposal site. The salt marshes within the estuary have several small tidal creeks bisecting the marsh area. No detailed surveys have occurred within these areas.

Typical salt marsh peat is present in the estuary area, while the salt marsh along Logan Airport typically occurs on a stone and boulder substrate. The salt marshes around Logan North are subject to the ebb and flow of the tide.

Biological Conditions Of Coastal Wetlands: As mentioned previously, vegetation within the salt marshes are typical of the region. *Spartina alterniflora* and *Spartina patens* are typically dominant, with species such as glasswort (*Salicornia* sp.) and sea lavendar (*Limonium caroliniensis*) present as well.

Visual observations indicate that vegetative interspersion is limited, but that density appears normal for a salt marsh (i.e., no unvegetated or sparsely vegetated areas are present).

No sampling of aquatic invertebrates has been conducted within the salt marsh. It is assumed that a pollution tolerant community typical of salt marsh areas in Boston Harbor is present.

Fish likely make use of certain portions of the salt marsh creeks during parts of the tide cycle.

Although there has not been any site specific shellfish sampling conducted in the tidal creeks and flats among the wetlands, it is likely that soft-shelled clams and mussels are present. Should bacteriological improvements continue in this area, these shellfish resources may also be opened to harvesting by Master Diggers.

No site-specific wildlife observations have been made in the site area. However, it is likely that waterfowl occur at Logan North.

4.8.4(h) Logan Airport West

Site Description. This area is located adjacent to the Logan Airport North site (Figure 4.32). Constitution Beach is to the north of the site, and a large marsh area is located to the west.

The site has never been used for disposal. It is a marine underwater borrow pit created by dredging for the expansion of Logan Airport. The site is located 2 miles from the East Boston excavation site by truck and 3 hours from marine transfer stations by barge.

Tidal Waters: There are no data to describe substrate conditions, but mud, silts, and clays were observed and it is reasonable to assume that the substrate conditions are similar to those described for the Logan North disposal site. It is also reasonable to assume that water conditions are similar to those described for the Logan North disposal site.

Mudflats And Coastal Wetlands: Conditions described above for Logan North are adjacent to Logan West. Land use is the same as that for the Logan North site and includes the presence of the MDC swimming facility at Constitution Beach.

Biological Conditions: The marine vegetative resources in the tidal mudflats have been examined around Logan Airport. No eel grass or widgeon grass has been found.

Fisheries diversity and abundance has been described for Logan North, and the fishery habitat at the Logan West disposal site is very similar.

Shellfish resources are present around the Logan West site. While there are no population statistics available, the Wood Island Flats were opened to harvesting by Master Diggers during the 1989 summer. The opening was prompted by improved bacteriological conditions resulting from water quality improvements made at the CSO treatment facility near Constitution Beach.

4.8.4(i) Spectacle Island

Site Description. Spectacle Island originally consisted of two islands connected by a sandbar. It was first acquired by the City of Boston in 1634. Uses included timbering and pasturing, and later, in 1649, agriculture. By the early 1700s, ownership of the land had become totally private. A quarantine hospital was erected and used until 1739. During the 1790s, two hotels were built, but were closed by Boston Police after gambling raids in 1857. The next major use of the island was for horse rendering, generating such products as hides, glue stock, horsehair, neat's-foot oil, and bones. The horse rendering operation had closed by 1910 and was replaced by a cattle rendering operation and grease extraction from garbage. In 1935, the grease extraction plant was abandoned. The City continued to dump raw garbage and rubbish on the island until 1959, when the South Bay incinerator was opened. The island's landfill has not been capped, and open refuse is common. Storms, high tide, and rainfall cause erosion into Boston Harbor. Therefore, there is a strong need to close and protect from erosion forces the existing landfill on Spectacle Island if the Boston Harbor clean-up plan is to meet its objectives.

Spectacle Island is currently designated as part of the Boston Harbor Island State Park and is owned by the Massachusetts Department of Environmental Management (DEM) (24 acres) and the City of Boston (73 acres). A plan for the development of Spectacle Island has been adopted by the DEM. This plan, entitled Boston Harbor Islands State Park 1986 Master Plan, envisions a system of paths and lookouts, hillside meadows, a pier and transient marina, a visitor's center with exhibits, picnic areas, a swimming beach, a boardwalk across a salt marsh, environmental artwork, and viewing points.

The present condition of Spectacle Island precludes its use as a park because of the extensive unsafe and unsightly conditions which prevail. In addition to the leachate which emanates from the landfill onto the shores and into the surrounding waters, the unstable, crumbling cliffs of refuse are a serious safety hazard. The beach and intertidal flats are strewn with broken glass, scrap iron and other metals, bricks, ceramics, concrete pieces and several decaying barges (Figure 4.34). Onshore, the ground is also strewn with broken glass, scrap iron and other materials mentioned above. It is dangerously uneven in many locations and is the site of several abandoned, decaying buildings, including a tall concrete chimney.

Spectacle Island is located 2 hours by barge from marine transfer stations.

Natural resources on Spectacle Island have been inventoried through a study conducted by the DEM, and further site investigations were conducted as a part of the Artery/Tunnel Project (see Figure 4.35) and MWRA Residuals Management Study.

Topography, Geology, And Soils. Spectacle Island is one of more than 30 islands located in Boston Harbor. It lies in the area called the Outer Harbor, approximately 1 mile southeast of Fort Independence at Castle Island (see Figure 4.36). Most of the Harbor islands, including Spectacle Island, are partially submerged drumlins (rounded hills composed of glacial till). The topography of Spectacle Island is characterized by a northern and a southern drumlin, connected by a lower ridge (a tombolo) that slopes steeply to the east and more gently to the west. The northern drumlin forms the high point of the island, which is 100 feet above sea level.

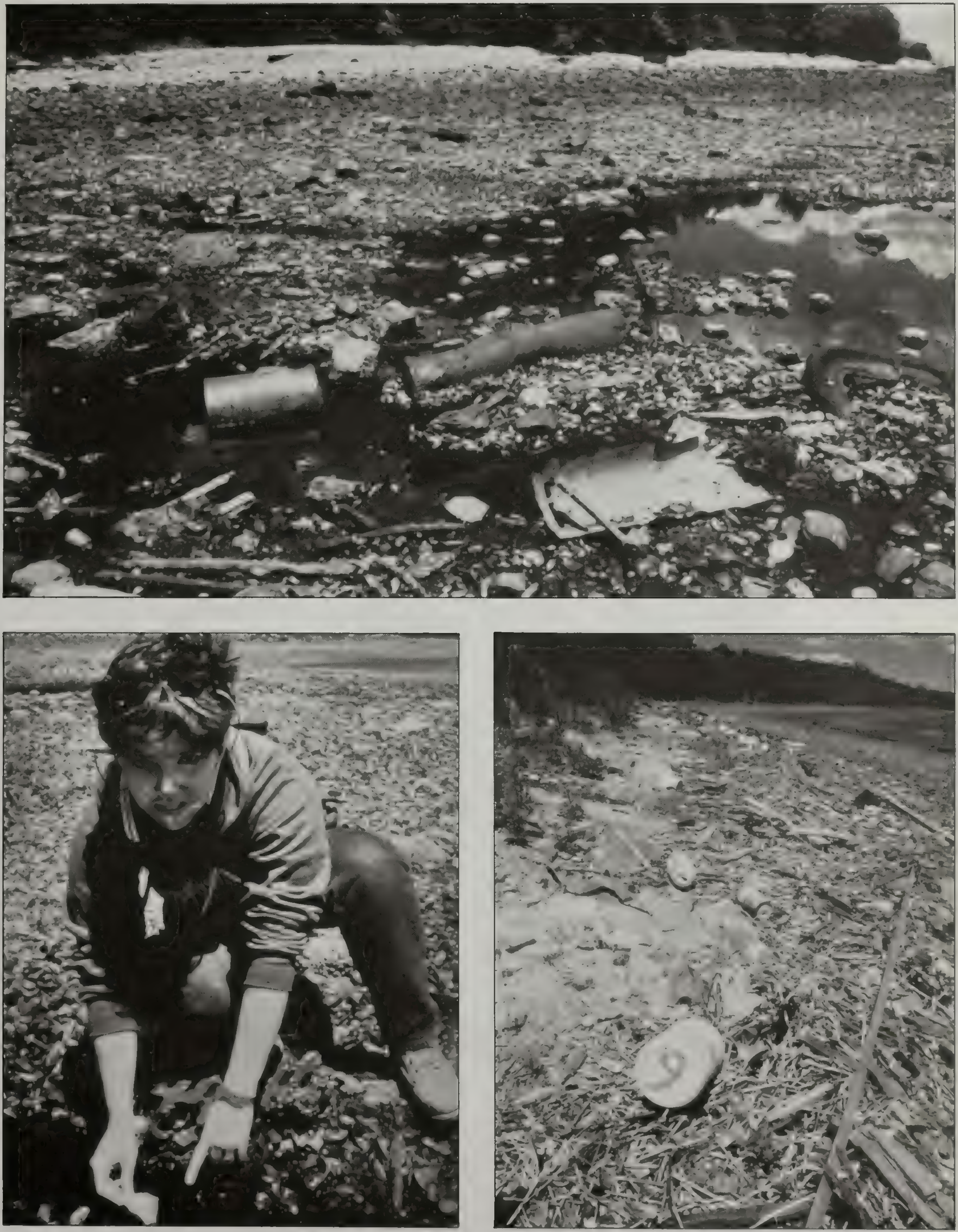
Bedrock beneath Spectacle Island is Cambridge argillite, which consists of gray argillite and minor quartzite with local occurrences of sandstone and conglomerate. Disposal of refuse and other landfill material has resulted in the formation of one large island of approximately 96 acres, of which approximately 38 acres consist of refuse fill, ranging in depth from 10 to 85 feet. There has been considerable erosion of refuse along the eastern side over the past 20 to 30 years, as shown by aerial photographs. Studies of the island indicate that landfill refuse extends 100 to 200 feet offshore from the existing cliff on the eastern side of the island.

Hydrographics.
Description Of The Outer Harbor/Bay: The Outer Harbor covers an area roughly 6 miles long and 5 miles wide. Much of the area is shallow with depths at mean low water (MLW) of less than 10 feet, except in the President Roads and Nantasket Roads areas where depths of 30 to 50 feet are maintained. A number of small islands are scattered throughout the Harbor. The complex topography results in correspondingly complex water circulation patterns.

Tides, Wave And Circulation:

- o Tides: The Boston Harbor ecosystem is affected by tides. The mean tide range is 9.5 feet, and the range for maximum spring tides is 14.5 feet. High tide levels can increase substantially because of storm surge action, with peak observed values up to 5.7 feet above mean high water.

- o Wave Climate: Because of Spectacle Island's location in the Outer Harbor and sheltering from adjacent islands, such as Long Island, the wave climate on the northwestern, western, southwestern, and southern sides of Spectacle Island is relatively mild and results primarily from local wind conditions. The northern, northeastern, and eastern sides are subject to ocean waves entering the Outer Harbor between Deer Island and Long Island. Hence, wave conditions in Broad Sound and Massachusetts Bay are important to the wave climate for Spectacle Island.



FIGURE

4.34 **Existing Environmental Conditions On Spectacle Island**

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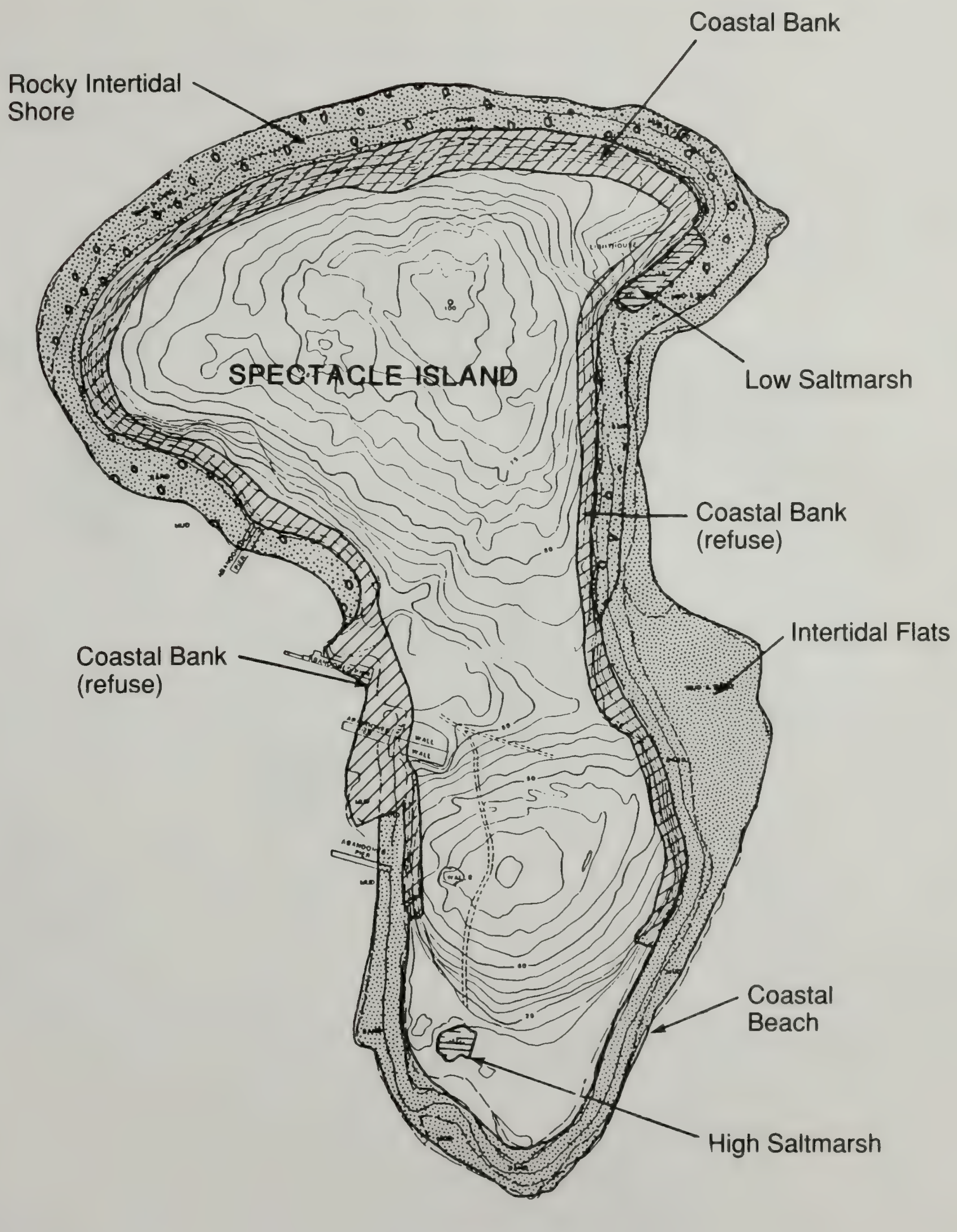
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

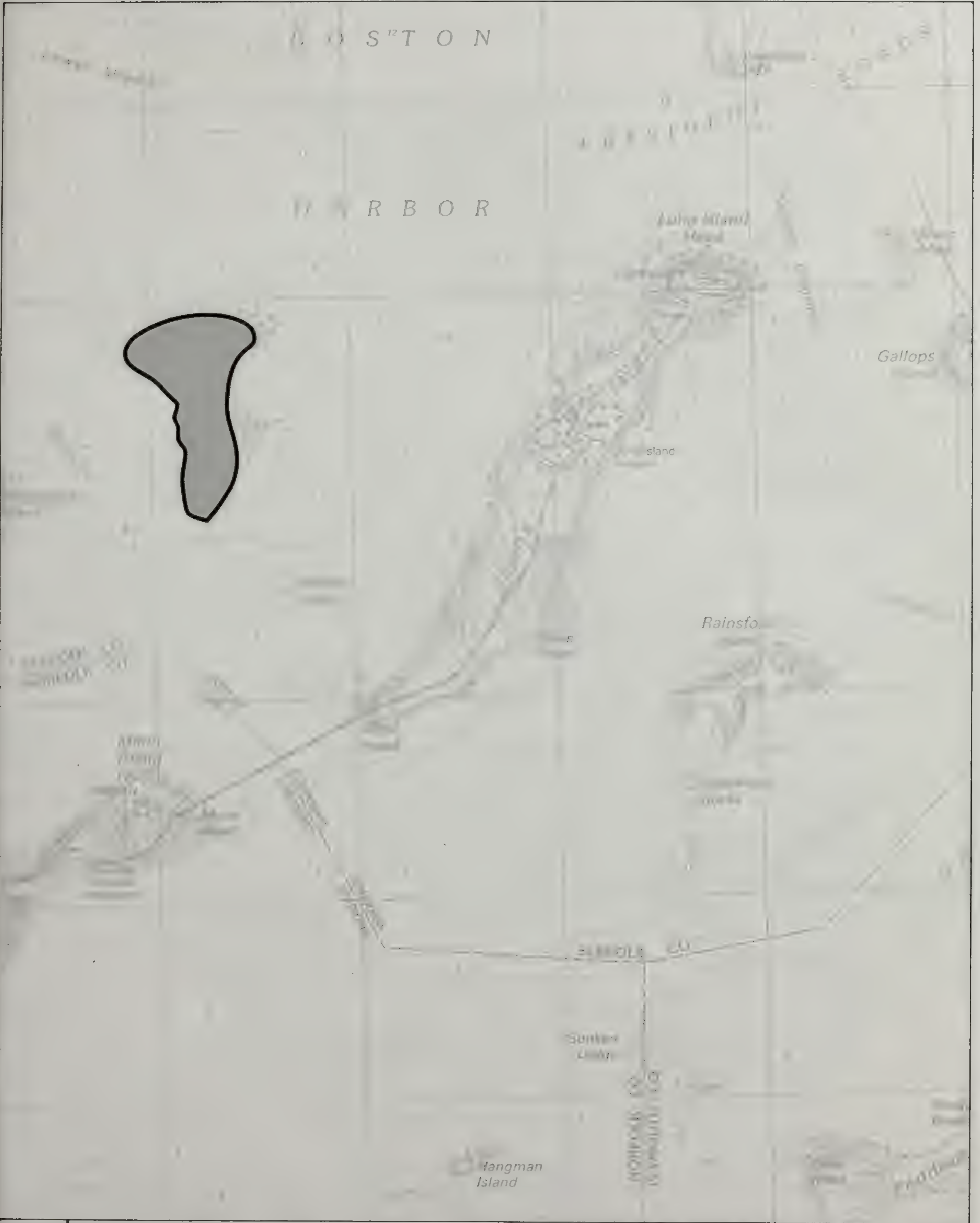


FIGURE

4.35 **Spectacle Island Resource Areas**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 520 Feet



FIGURE

4.36

Spectacle Island

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
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SUPPLEMENTAL EIS/R

0 .5 MILES

- o Circulation: Water circulation in the Boston Harbor/Massachusetts Bay system is affected by a number of factors. The tide is the dominant factor, particularly in the Inner and Outer Harbor, and Broad Sound regions. For Spectacle Island, the circulation in the Outer Harbor is of primary interest. Other factors affecting circulation include tidal effects, wind effects, freshwater runoff, and stratification.

Water Quality: Waters of the Commonwealth of Massachusetts are classified by the Division of Water Pollution Control according to their intended uses. Coastal waters (Spectacle Island is isolated from all freshwater bodies) are designated as Class SA, SB, or SC. Boston Harbor in the vicinity of Spectacle Island is a Class SB surface water, which is designated for use as a marine fishery, primary and secondary recreation, and shellfishing subject to restrictions and deputations. As of 1986, this section of Boston Harbor was listed as being in partial support of the SB classification. The MWRA has reported violations of total coliform standards near Spectacle Island. Additionally, metals and polynuclear aromatic hydrocarbons have been found in sediments. The Deer Island and Nut Island wastewater and sludge discharges are major contributors to these environmental quality problems.

Samples of leachate emanating from the landfill were collected at 10 locations around Spectacle Island, including eight sites along the mid-tide line on beaches on the east and west sides of the island and two locations at the landfill base where leachate was dripping from the refuse. The samples were analyzed for general water quality parameters, priority pollutant metals, volatile organic compounds, semi-volatile organic compounds, and pesticides and PCBs. A summary of those data is included below. (A complete data report is contained in the report Sediment Chemistry and Marine Biological Analysis Spectacle Island, Boston Harbor, Bechtel/Parsons Brinckerhoff, 1990.)

While the concentrations of individual compounds varied by location, most were in the moderate to high range and some can be classified as excessive. For the general water quality parameters, the analyses indicated very high concentrations of nitrate nitrogen, ammonia nitrogen, Kjeldahl nitrogen, total phosphorous, chemical oxygen demand, volatile solids, iron, manganese, total organic carbon, and bacteria. Hydrogen ion (pH) levels were within acceptable ranges for Class SB water. Two samples had low levels of phenols, cyanide, and oil and grease. No petroleum hydrocarbons were detected. Moderate to high concentrations of such priority pollutant metals as copper, lead, and zinc were found. The only volatile organic compound found was benzene which was present in the two samples of leachate from the refuse proper. Di-N-butylphthalate was the only semi-volatile compound present, and it was found in two samples collected along the beach. No pesticides or PCBs were present.

Temperature of leachate collected along the beach varied. One sample was equal to the temperature of Harbor water while the remainder ranged from 2°C to 5°C above that of Harbor water. Leachate dripping from the landfill had a temperature of 29°C, which was 12°C above air temperature and 17°C above Harbor temperature.

Marine Sediment Quality: Marine sediments around the island were tested in the fall of 1988. Sediment samples from the north side of the island were clean and could be placed in Category I of DEP's classification for dredged and fill materials (see Figure 4.37).

Conditions on the east side of the island varied from clean to contaminated. Arsenic caused four samples on the east side to fall into Category II and Category III levels.

Sediments from the west side contained much higher levels of metals, PCBs, and PAH compounds. Sample ST1-2, from within the area where garbage scows were unloaded, was the most highly contaminated of the locations around Spectacle Island. From the distribution of location of high concentration samples, it appears that the contamination from past uses spreads from near the northwest side through the southern tip.

Marine Life. Nearly 4 dozen species of fin fish have been observed in Boston Harbor waters. The same fin fish that inhabit other parts of the Harbor should also be common around Spectacle Island, including the winter flounder.

According to the MWRA, lobster pots are found in moderate abundance around Spectacle Island, suggesting the presence of a lobster (*Homarus americanus*) population.

The benthic resources around Spectacle Island were evaluated during the fall of 1988. Fifty-five benthic species were found, and over 50 percent were polychaete worms. Arthropods accounted for 22 percent of the benthic community, and molluscs comprised over 18 percent of the species found. Predatory worms were more common on the coarser bottom, while detrivores were most common on soft mud.

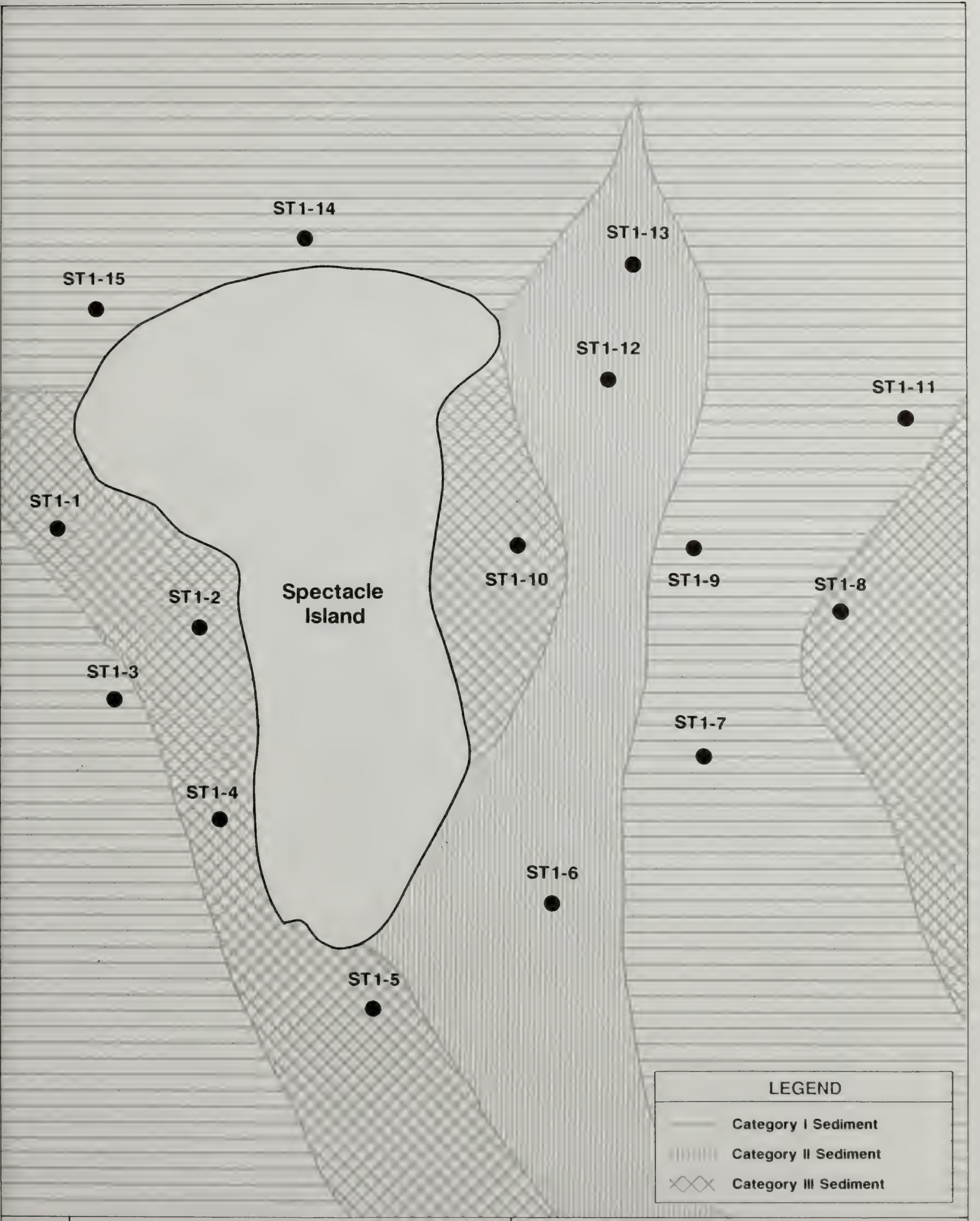
Ordinal (cluster) analysis of benthic sampling locations using data on invertebrate fauna indicated a relationship between biological and chemical conditions of sediments. In particular, benthic fauna on the west side of the island appear limited by chemical contamination of sediments. However, invertebrate composition of some Category III sediments appear to be affected more by sediment composition than by quality.

Field surveys were conducted during 1989 and 1990 to determine the extent of shellfish resources around Spectacle Island. A total of 222 cubic feet (cf) plots among 20 transects were excavated and the sediment screened for the presence of soft-shelled clams. Surveys were also conducted at Thompson, Long, and Moon Head Islands for comparison purposes.

The survey on Spectacle Island indicated that the soft-shell clam (*Mya arenaria*) is present but not abundant, with an overall density of 0.40 individuals per cf. Densities were less than one legal size clam (> 5.1 cm) per cf and are not considered a commercial resource. Distribution was extremely patchy, reflecting the presence of marginal habitat.

While softshell clams were found on 12 of the 20 sample transects, only the five transects located on the northeast corner of the Island contained more than 2 clams for the entire transect length. In these five transects, the clams were typically located in the mid-tidal region of cobble stone areas with underlying soft substrates. By comparison, 2.5 and 0.2 soft-shelled clams were found per cf at Thompson and Long Islands, respectively. None was found in the flats at Moon Head. Shellfish harvesting around Spectacle Island is prohibited by the DMF because of high bacteria levels.

During the field surveys it was also determined that the blue mussel (*Mytilus edulis*) is present in the tidal waters and common on the intertidal areas along the northern and eastern side of the island. Mussels are also located on the southern portion of the west



FIGURE

4.37

Hypothesized Limits Of Sediment Contaminants

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SUPPLEMENTAL EIS/R

0 300 600 1200 FEET

shore of the island just south of the concentration of derelict barges. Approximately 14.7 acres of blue mussel (*Mytilus edulis*) beds are located in the rocky intertidal shoreline along the east and north and southwest shores of the island. Density of the blue mussels ranged from 1 to 267 per square foot and extended into approximately 5 feet of water below the low tide line. No other shellfish resources have been found in the tidal waters around the island.

Mammal diversity and abundance in tidal waters adjacent to the island is limited. Species of marine mammals most likely to occur, although their presence is uncommon in the Harbor, include harbor porpoises (*Phocena phocena*) and grampuses (*Grampus griseus*) (Fiorelli, 1982). Harbor seals (*Phoca vitulina*) have also been observed during studies on Spectacle Island.

A variety of waterfowl use the tidal waters in the vicinity of Spectacle Island, particularly on the eastern side. Bird species which have been observed both on and adjacent to Spectacle Island include the black-crowned night heron, great cormorant, snowy owl, black-backed gull, herring gull, white-winged scoter, common goldeneye, common eider, bufflehead, mallard, black duck, merganser, scaup, killdeer, yellow warbler, chestnut-sided warbler, and red-winged blackbird. Species most likely to use the tidal waters include the great cormorant, herring gull, white winged scoter, common goldeneye, bufflehead, mallard, black duck, merganser, and scaup.

Spectacle Island has historically been a breeding ground for several bird species, including the glossy ibis, black-crowned night heron, green-backed heron, snowy egret, and the great egret. These species likely used the waters adjacent to Spectacle Island, particularly the intertidal areas, as feeding grounds. In 1984 a survey of nesting pairs was conducted (Hatch, 1988). The survey indicated that one great egret, 40 snowy egret, 60 night heron, and 10 glossy ibis were nesting along the northern and northeastern fringes of the Island. Another 1,000 pairs of various gulls have been reported using the Island. However, recent sites visits by Cortell, MWRA, and Bechtel/Parsons Brinckerhoff biologists have revealed that the rookery was not occupied during the 1988 or 1989 breeding seasons and few nesting gulls have been present. Conversations with both the MA Natural Heritage Program and the MA Audubon Society report that these species have alternate nesting sites in the Harbor, and that they have likely relocated to those areas.

Aquatic Resources.

Wetlands: There are six coastal wetland resource areas at Spectacle Island (see Figure 4.38). No inland wetland resource areas are present. These resources are included in the concerns addressed by the Clean Water Act Section 404 and the analyses involved in the 404(b)(1) Guidelines.

Land Under The Ocean: Pursuant to 310 CMR 10.25(2) of the current WPA regulations, land under the ocean is defined as land extending from mean low water seaward to the limit of State jurisdiction. The land under the ocean in the vicinity of Spectacle Island is capable of providing flood control, storm damage prevention, and habitats for shellfish, fisheries, and wildlife.

Coastal Beaches: A coastal beach is presently defined in 310 CMR 10.27 as that area of unconsolidated sediment which occurs from mean low water landward to the bank line. The coastal beach along the shores of Spectacle Island is approximately 19.5 acres. The sediments are generally comprised of mud, small rocks, mussel shells, and refuse.

The coastal beaches are capable of protecting water supplies and providing flood control, storm drainage prevention, and habitats for fisheries and wildlife. The quality of the resource area fisheries and wildlife habitat is reduced by the presence of contaminants and trash from the adjacent landfill.

Coastal Banks: Coastal banks are currently defined in 310 CMR 10.20(2) as the seaward face of any elevated landform which lies at the edge of land subject to tidal action. There are 9,400 linear feet of coastal bank at Spectacle Island. These banks consist of natural materials to the north and south and refuse in the middle sections. The eastern and northern banks are subject to the most erosion.

The coastal banks of Spectacle Island are capable of providing flood control and storm damage protection. However, erosion occurring along the bank face, particularly on the eastern shore, indicates that these banks currently are not functioning well as storm damage prevention.

Rocky Intertidal Shores: Rocky intertidal shores are defined as naturally occurring rocky areas which are situated between mean high water and mean low water, pursuant to 310 CMR 10.31(2). Rocky intertidal shores adjacent to Spectacle Island total approximately 18.4 acres. They are primarily located on the northern and eastern shores where wave energies are highest. The rocks and stone found in this area are up to 1 to 2 feet in diameter.

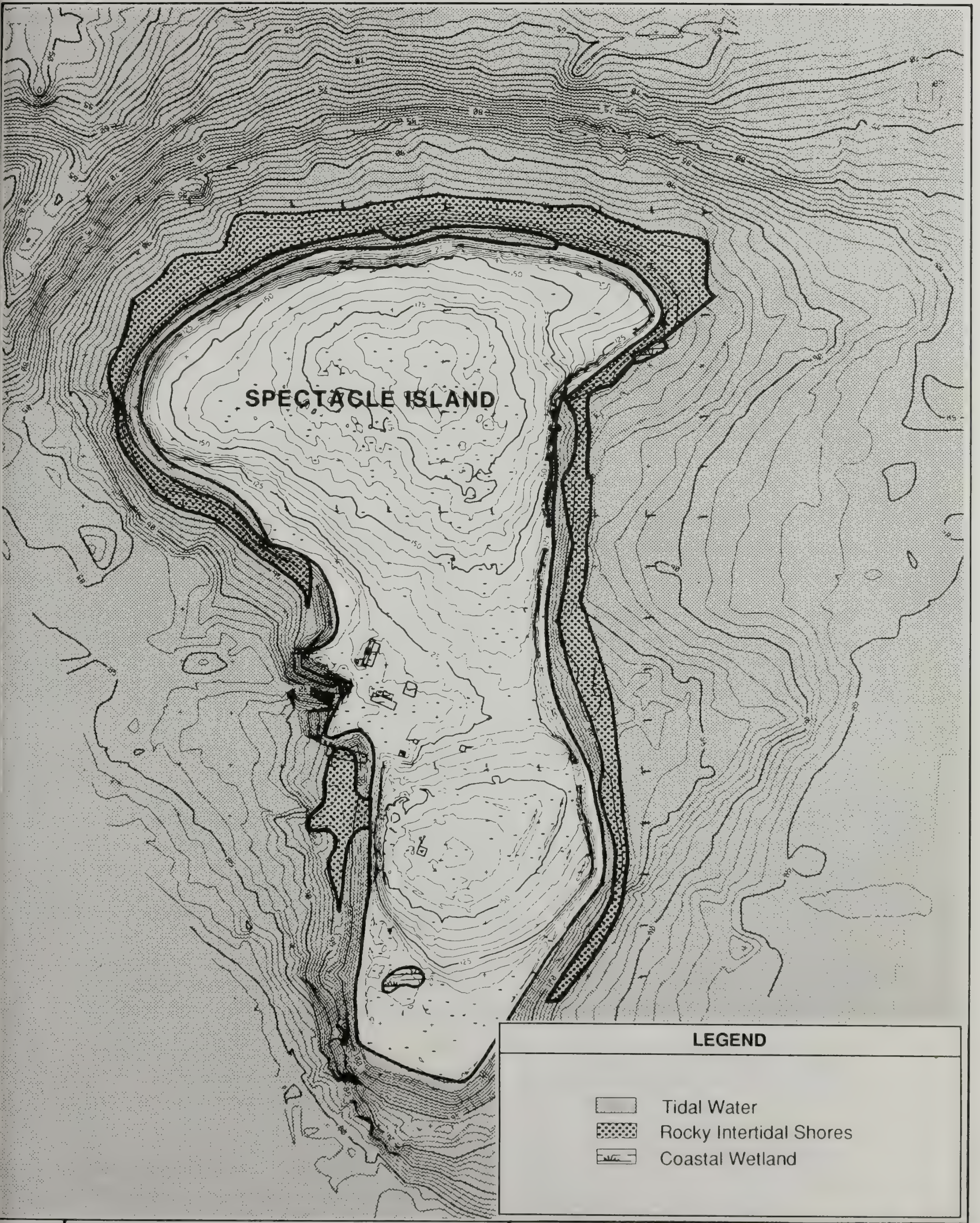
The eastern side of the Island has a shoreline dominated by stone with smaller amounts of mud, sand, shells and refuse. The low tide elevations of the east shore are relatively flat areas dominated by pebbles and mussel shells atop a silt muck. The northern side of the Island has a rocky beach, with virtually no fine grain material except in the areas near high tide. This continues around to the northwestern shoreline where cobble beach is present.

Given the results of the chemical analyses on offshore sediments, and the results of the leachate analyses, it is reasonable to assume that large portions of the rocky intertidal shore along the eastern shore are contaminated.

The chemical characteristics of waters in and adjacent to the rocky intertidal shore on Spectacle Island are generally similar to the tidal waters. It is important to note, however, that areas along the eastern side of the Island are subject to contamination from leachate.

Rooted marine vegetation, such as eel grass and/or widgeon grass, has not been found on the rocky intertidal shores around the Island. The rocky intertidal shores contain small amounts of attached marine algae. Approximately 4,935 square feet of *Spartina alterniflora* is growing between the rocks on the northeast side of the Island.

The rocky intertidal shore on the east side of Spectacle Island is contaminated by leachate from the landfill. Along the north side of the Island, patches of blue mussels with



FIGURE

4.38

Spectacle Island Aquatic Resource Areas

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amphipods, isopods, and worms can be found. Barnacles and periwinkles are present on rock surfaces within the lower intertidal zone.

During high tide, it is likely that fish swim through and forage within the submerged rocky intertidal area, feeding on worms and small crustaceans. It is unlikely that the mussels themselves offer a major food source for fish.

Shellfish are scattered in the rocky intertidal shoreline. Soft-shelled clams and blue mussels can be found in this resource area. No lobsters inhabit the rocky intertidal shoreline because of the exposure at low tide.

Coastal Wetlands: There are two coastal wetland areas on Spectacle Island. A low salt marsh occupies a thin bank on the beach face along the northeastern side of the Island. A high salt marsh area is located on the low plateau at the southern end of the Island. These wetland areas have been delineated in accordance with the Federal Manual For Identifying And Delineating Jurisdictional Wetlands (Federal Interagency Committee For Wetland Delineation, 1989), using the required NEDCOE forms, and their location subsequently surveyed.

The low salt marsh is about 4,935 square feet and is found in an area with a substrate comprised of rocks. The high salt marsh is located on the remains of a pier structure in an area underlain by fill material.

The low salt marsh is inundated by harbor water, and thus previous discussions about suspended particulates and turbidity in tidal water also pertain to this wetland area. The quality of harbor water is not directly applicable to the high salt marsh because no standing or permanent bodies of water are present there. The low salt marsh consists mainly of *Spartina alterniflora*. The high salt marsh consists mainly of *Spartina patens*.

Several species of birds have been noted on Spectacle Island during site visits. However, given the small size of the two salt marshes, wildlife use of these areas is limited.

Land Containing Shellfish: Pursuant to 310 CMR 10.34(2)(a), land containing shellfish is defined as land under the ocean, tidal flats, rocky intertidal shores, salt marshes, and land under salt ponds where shellfish are present. A total of approximately 14.8 acres of land containing shellfish exists on the rocky intertidal shore and land under the ocean located at the northern and eastern edge of the island.

Vegetation And Wildlife. Since landfilling ended in 1960, most of the island has become revegetated with successional plant species. Grasses, sumac, cottonwood, and elm occupy the southern drumlin. The dominant vegetation is staghorn sumac.

The eastern side of the central landfill area is covered by dense briars and shrubs with an overstory of staghorn sumac and apple trees. To the west, field grasses and low shrubs surround the old buildings and piers.

Staghorn sumac and cottonwoods cover the natural ground surface thickly on the northern drumlin. A transition to old field and thicket communities occurs in the landfilled areas, with shrubs and grasses extending down the banks on the northern faces.

No mammals were observed during reconnaissance of the island. However, rodent burrows were found, and it is possible that raccoons (*Procyon lotor*) may be inhabiting the island.

As previously described, several bird species have been noted during site visits. Snowy egrets, night herons, and glossy ibis nested along the northern and northeastern fringes of the island during 1984, but no nesting pairs were observed in 1988 and 1989. Nesting herring gulls and black-backed gulls occupied the northern part of the landfill area and the central part of the north drumlin in 1984. However, these numbers have not been present the past two years.

Threatened And Endangered Species. No Federal- or State-listed threatened or endangered wildlife species have been reported or observed on Spectacle Island.

Floodplains. Flooding in Boston Harbor occurs because of a combination of the high tides and storm surges that accompany hurricanes and major storms. Along its entire perimeter, Spectacle Island is subject to floods and associated wave action. The 100-year flood elevation is +10 feel MSL.

Small areas at the southwest corner and west-central landfill zone are located at elevations between the 100-year and 500-year flood levels. Elevations on the remainder of the island lie above the limits of the 500-year flood and would be subject to minimal flooding.

Adjacent Land Use. Boston Harbor waters completely surround Spectacle Island. These waters host recreational fishing and commercial lobstering. Three other Harbor islands lie within about 1 mile of Spectacle Island.

Long Island, to the east of Spectacle Island, is owned by the City of Boston and includes an area of 214 acres. It is currently the site of Long Island Chronic Disease Hospital.

Moon Island, to the south, consists of approximately 45 acres and is owned by the City of Boston. The island is the site of a training facility for the Boston Fire Department, and the Boston Police Department also maintains an outdoor pistol range and training center there.

Thompson Island is a 157-acre island southwest of Spectacle Island and north of Squaw Rock in Squantum. The island is privately owned and operated by the Thompson Island Outward Bound Education Center. It serves over 20,000 visitors per year for a variety of educational and recreational programs.

Air Quality. Spectacle Island is approximately 1.2 miles east of the nearest South Boston shoreline, about 1.6 miles south of Logan Airport, and north northeast of the Squantum shoreline in Quincy. Because of the distances to areas where the main sources of pollution are located, the existing air quality is expected to be no worse, and probably better, than that for the general project area. Since ozone is considered to be a regional pollutant, the ozone levels at Spectacle Island are probably similar to those measured at the Chelsea monitoring station.

Noise And Vibration. Noise levels were measured during daytime and nighttime hours on Monday and Tuesday, June 13 and 14, 1988, on Long Island, the closest inhabited area to

Spectacle Island. The average daytime noise level was L_{eq} = 54 dBA and the nighttime level was L_{eq} = 40 dBA.

The major sources of daytime noise noted during the field study consisted of aircraft and power boats. Some noise was also discernible from automobile traffic to the hospital. There was no noticeable contribution to measured noise levels from construction or other nonrepresentative conditions. Nighttime noise levels were lower primarily because of reduced air, water, and land transportation activities. The measured noise levels are well below the FHWA Standard of L_{eq} = 67 dBA for acceptable residential use.

Cultural Resources. Spectacle Island was placed on the National Register of Historic Places in 1986 as a part of the Boston Harbor Islands Archaeological District because of its known and potential prehistoric resources (see below).

There are no standing intact structures on Spectacle Island. A study of abandoned and decaying structures inventoried wharves, garbage disposal plant structures, and remnants of range lights, including several fragments of the architectural railing and the conical roof from the 1904 rear range light on the north drumlin. All are late 19th and 20th century structures and are not considered eligible for listing in the National Register of Historic Places.

Archaeological Resources. A prehistoric archaeological site (19-SU-38) is a contributing element to the Boston Harbor Islands Archaeological District. Site 19-SU-38 was located and tested to establish its extent and date. It is a prehistoric shell midden 25 meters in length, 8 to 10 meters wide, and 20 to 40 cm in depth. One diagnostic lithic artifact, believed to be a Neville-Variant projectile point, was recovered dating to the Middle Archaic Period [8,000 to 6,000 years before present (B.P.)]. No other significant prehistoric sites were discovered during an intenstive archaeological survey (Jones *et al.*, 1989). Because of the extent of the landfill and intensive 20th century development, any other prehistoric sites would have been buried or destroyed.

Visual Features. Originally, the two drumlins which comprised Spectacle Island were the primary land masses of the island. They were connected by a sandbar, thus resembling spectacles. The shape and northeast/southwest directionality of the original Spectacle Island was consistent with the other Inner Harbor islands. The central part of the island, which was originally a low sandbar and mudflat, is today covered by a deposit of refuse over 70 feet deep. The current shape results from the garbage placed along the sandbar, and is not similar to the original glacial formation of the island. The island still has a two-drumlin profile, but a steep cliff of refuse has been created along the eastern face between the drumlins.

4.8.5 Environmental Impacts Of Potential Disposal Sites

This section describes the environmental impacts associated with the use of each proposed disposal site, and evaluates each site based on criteria including existing technology, logistics in light of overall project purposes, and adverse environmental consequences.

A more detailed illustration of potential environmental impacts for all the proposed disposal sites including Nontidal Waters, Substrate, Suspended Particulates and Turbidity, Water, Biological Conditions, and Inland Wetlands may be obtained from the Central

Artery/Third Harbor Tunnel Project Aquatic Resources Functions And Values, Volume II, Material Disposal Alternatives.

4.8.5(a) Massachusetts Bay Disposal Site (MBDS)

The EPA has determined that the disposal of materials that meet the ocean dumping testing criteria do not result in long term adverse impacts at the MBDS (USEPA, 1989). The site is recommended for disposal of acceptable dredged material, as described in Section 4.6, because disposal of acceptable dredged material at this site is technologically feasible and cost-effective, and adverse environmental consequences are minimal.

4.8.5(b) Site BED10 (Bedford)

Site Description. This 183-acre site is located to the northwest of Hanscom Airfield and southeast of the Concord River in Bedford (see Figure 4.15). The part of the site adjacent to the Raytheon property appears to be used for minor dumping. The remaining part of the site is predominately forest.

The disposal plan at Bedford allows for the placement of approximately 2,746,000 cy of material in the landfill. This would include approximately 2,128,000 cy of material from the project, the remainder being imported for the landfill closure system. The limits for the footprint of this landfill was determined by maximizing the landfill capacity while avoiding aquatic resource areas considered to be most valuable (see Figure 4.39). The areas avoided included two areas of emergent growth located on the northern and eastern portions of the property, the somewhat vegetatively diverse wetlands on the western edge of the property, and the wetlands immediately adjoining Elm Brook. The majority of the wetlands which this footprint does impact are transitional and characterized by a mix of upland and wetland plant species. Approximately 58 acres of wetlands and 5,250 linear feet of ditches would be filled using this plan. In addition, the stream in the northwest corner of the site would have to be rerouted.

Construction of the landfill would require the stripping of the topsoil and hydric soils to a firm substrate. This may require dewatering of the land area itself to lower the water table as well as dewatering within the excavation site. Suspended solids would be produced during this process. To preclude adverse impacts to receiving waters, a detailed sedimentation and erosion control plan would have to be prepared. This plan would include specifications on the control of turbidity at the source as well as measures to remove suspended particulates before discharge. However, one cannot discount the possibility that suspended particulates would escape and have an impact to Elm Brook and its tributaries.

Following construction, it is assumed that untreated surface runoff would not be allowed to enter Elm Brook until the landfill surface has become fully vegetated. It has also been assumed that leachate from within the landfill would be collected and treated to a water quality based effluent limitation prior to discharge to Elm Brook.

Aquatic Resources. Aquatic resources affected by landfill construction at this site include: nontidal waters and inland wetlands.

Nontidal Waters: The greatest impact to nontidal waters would occur in Elm Brook during dewatering prceedures.

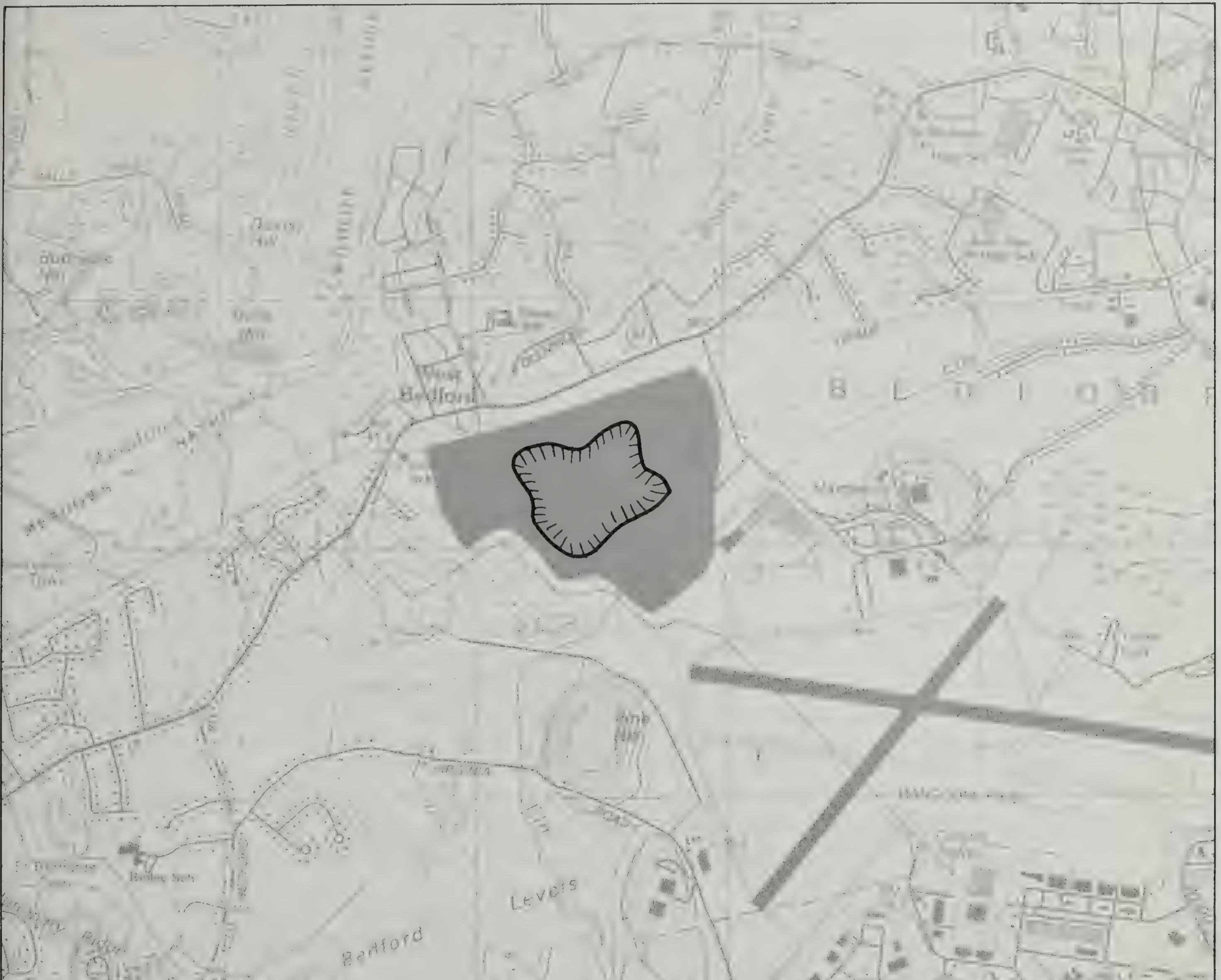

FIGURE 4.39

Site BED 10: Landfill Footprint

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0 .5 MILES

Chemical Characteristics Of Nontidal Waters: Dewatering of the site is necessary for placement of the liner. In such instances, it is common to find that when pumping or draining wetland soils, very low pH levels are present along with high levels of tannic acid, coloration, and nitrogen compounds. It is possible that the very low pH of the wetland water could endanger fish and other aquatic life in Elm Brook. Additional nutrients would result in the increased growth of rooted aquatic vegetation, duckweed, and algae and could affect the quality of the Burlington water supply. Treatment of this water would be necessary before discharge.

Biological Conditions Of Nontidal Waters: The major potential impacts to biological conditions include effects on vegetation, aquatic biota, fisheries, and wildlife as described below.

There likely would be permanent changes in the composition of invertebrates in the remaining wetlands and streams. The type of stream habitat that results from the relocation of streams could reduce species diversity.

Fish mortality could result from the accidental discharge of untreated low pH wetland waters pumped to lower the water table and/or dewater the excavation site. There could also be temporary impacts during rerouting of streams because of siltation, and, if lost overhead vegetation is not replaced, stream temperatures could rise. A lowering of base flow resulting from altered drainage could also have an impact on the fishery during low flow periods.

Major losses to this resource include the drainage, the 0.7 mile tributary waters to Elm Creek, and Elm Creek's possible relocation (about 1,300 feet).

Public And Private Use Of Nontidal Waters: It is believed that part of the Bedford site is within the Zone II for the adjacent Hartwell Road wellfield. If the landfill were sited in Bedford, additional measures could be necessary to ensure that leachate from within the landfill did not enter the groundwater. This might include a double liner with leachate collection between the liners. As stated above, it is also assumed that the leachate would be treated to meet water standards. These steps would reduce to the maximum extent possible the chemical contamination of groundwater.

Given the potential presence of the Zone II, it is also possible that there would be a change in the recharge and capacity of the aquifer which would be attributed to the loss of contributing recharge area.

Inland Wetlands: The total area of inland wetlands is approximately 58 acres of the total 183 acre site. Main vegetative impacts would occur within the forested wetland areas, particularly the more transitional wetlands which support a mixture of upland and wetland species. The filling of 58 acres of forested wetlands is considered significant. Vegetative diversity would be reduced from transitional forested wetlands and seasonally flooded wetlands to a uniform grassy landfill area.

Hydrographics. There could be localized changes in water flow routes particularly with the covering of 58 acres of wetlands, covering of 5,250 linear feet of ditches, and rerouting of a stream. There could also be changes in the water balance for Elm Brook. In all likelihood there would be lower evapotranspiration from the landfill surface and stream flows could increase. However, dry weather baseflow could decrease. Surface water and potential groundwater flow patterns, combined with permeable soils, indicate potential downstream and offsite impacts. Therefore, a landfill at this site would definitely require lining and leachate collection/monitoring systems.

Terrestrial Habitat And Wildlife. The reduction of vegetative diversity of the site would result in a reduction of wildlife diversity and abundance. Remaining wetlands would be subject to disturbances during construction, and following construction the loss of adjacent habitat would reduce its suitability as habitat for some wildlife. For example, larger mammals such as deer, which could conceivably continue to use the undisturbed wetlands, subsequently may not have adequate upland forest habitat. The Great Meadows National Wildlife Refuge is about 1,000 feet to the northwest of the site and surrounds the Great Meadows River.

Traffic/Transportation Impacts. The daily truck traffic on Interstate I-93 would be increased by a maximum of 12 percent, and this would be a low impact (Draft Report, Analysis of Removal of Excavated Material Via Trucks, by Cambridge Systematics, Inc., January 1990).

Daily truck traffic on Route 62 could be increased a maximum of 238 percent, but that would be considered a very high impact. Pavement life would be reduced by 0.3 to 0.4 years for Interstate I-93 and I-95, and that would be a high impact. Pavement life would be reduced by 0.6 to 8.7 years for Routes 62 and 4/225, and that would be a very high impact. Roadway maintenance would require an additional pavement overlay costing $117,458 and local/primary roadway reconstruction and pavement overlay on the remaining would cost $234,817.

The annual cost of enforcement of routing restrictions, weight limit restrictions, and the use of roads at certain times of the day for the removal of all excavated project material is approximately $1,507,000. This is based on two patrol units 24 hours per day to enforce routing restrictions, one patrolman for 24 hours per day for each of the load site weigh scales, four patrol units for 12 hours per day for traffic control, and one community liaison officer full time for public awareness. Over the seven year period of the materials disposal program, the cost would be approximately $10.7 million, including the cost of equipment associated with the weigh stations. This total cost covers the disposal of all excavated project material if disposed at inland sites.

The planned trucking route to the proposed Bedford site via I-93 to Route 128 to Route 225 to Route 62 would require the repair of seven bridges to handle truck traffic to the site.

Land Use And Social Impacts. The surrounding area is vacant open space with the Raytheon parking lot on the eastern side of the site. Hanscom Airfield is located to the southeast. The Bedford well water treatment plant is to the east on the opposite side of Hartwell Road. A residential area is located to the west side of the site, and a few residential homes are situated along Hartwell Road on the eastern side of the site. Buffer areas would be required adjacent to the residential areas.

Relocation Impacts. This site is presently vacant; thus, relocation is not an issue.

Air Quality Impacts. Peak year operation of this site is projected to produce emissions equivalent to 10 tons of non-methane hydrocarbons and 52 tons of oxides of nitrogen, regionally.

Transportation Noise Impacts. There are sensitive noise receptors (residences) along the perimeter of the site. As trucks enter the site, they would likely cause adverse impacts on residences near the site perimeter where presently there is no significant truck traffic. Twenty-four-hour operation would not be feasible because of the residences in the immediate vicinity of the site. An increase of 1 dBA would be expected adjacent to the site during transportation operations, compared to no increase if materials disposal did not occur.

Predicted Noise Impacts During Fill Operations. Three distinct phases of fill operations (site preparation, spreading of material, capping), each requiring different assemblages of equipment, have been identified. As noise characteristics differ for operations in each of these phases, noise levels have been estimated separately by operation phase.

Operational noise levels at the site boundary were calculated by adding together the average noise levels from major noise producing equipment. These values were then extrapolated to receptors at set distances from the site boundary.

For the purposes of identifying noise impacts from filling activity at a screening level, a substantial impact was assumed to occur if an 80 dBA L_{eq} exposure to a residential district was predicted. This assumption is conservative in that a level of 80 dBA would result in an increase of 15 dBA over an ambient condition of 65 dBA at a residential area. Ambient noise levels in residential areas generally are substantially less than 65 dBA, particularly at night. Therefore, operational noise levels of 60 dBA could also cause a substantial (15 dBA) increase in area where ambient noise levels are 45 dBA, such as is common at night or in rural areas. An 80 dBA noise contour was therefore used to establish the perimeter boundary of impact areas.

For phases 1 and 2, site preparation and spreading of material, impacts are predicted if residential use is within 600 feet of the site boundary. For phase 3, capping of the landfill, impacts are predicted if residential use is located within 400 feet of a site boundary.

Substantial noise impacts resulting from the operation of the landfill are not predicted at this site.

Visual Impacts. The fill material will create a grassy hill (or series of hills) approximately 50 feet above grade. The surrounding wooded areas will help screen views of the site.

Summary.

- The site appears to be in a Zone II associated with the adjacent wells.

- 58 acres of inland wetlands would be filled.

- There would be a loss of the source and about 0.7 mile of a tributary to Elm Creek; loss of vegetated upland habitat; and potential relocation of about 1,300 feet of Elm Creek.

- This site would not meet the DEP landfill criteria, because of its wetlands and its probable Zone II delineation.

- Based on the above analysis, use of this site is not recommended, because it is neither available nor logistically workable given its failure to meet DEP landfill siting criteria, because existing technology is not available to ensure the integrity of the groundwater, and also because of the significant adverse environmental consequences of disposal at this site, including loss of wetlands and vegetated upland habitat.

4.8.5(c) Site MAL01 (Malden/Revere)

Site Description. This site in Malden is Rowe Quarry, which has been an active quarry since 1885. The site is located off Route 1 North with access from Lynn Street (see Figure 4.13). From East Boston, automobile travel time is slightly over 19 minutes in off-peak travel periods. The travel distance is 6 miles.

The Malden site in Rowe Quarry has the capacity for 3.6 million cubic yards, of which 2,656,000 cy would be material from the project, the remainder being imported for the landfill closure system. The walls of the quarry would require trimming, and a thick 12-foot layer of clay would have to be used to close the landfill against the walls. Drainage is provided against the back walls and beneath the landfill by a granular layer that drains to a leachate treatment plant.

Aquatic Resources.
Inland Wetlands: The inland wetland within the quarry would be filled. There are no other aquatic resource areas within the quarry to impact. A total of about 4 acres of palestrine wetlands are on-site. Active quarrying has limited their productivity and habitat value.

The site drains to a portion of the Rumney Marshes, which was recently designated as an Area of Critical Environmental Concern. This area consists of about 1,000 acres of salt marsh, tidal flats, and channels.

Because the inland wetland is being filled, there would be no other non-tidal resources to impact. It is assumed that there would have to be a collection system for leachate, which would have to be treated before discharge to the coastal wetland and the Pines River.

Coastal Wetlands: The coastal wetland could be impacted from uncontrolled runoff during disposal operations. However, this impact could be avoided through a sedimentation and erosion control plan that would be in effect until the cover was fully vegetated.

Public And Private Uses: There are no known public or private water supply uses on the site to be impacted.

Traffic/Transportation Impacts. The daily truck traffic on Route 1A would be increased a maximum of 60 percent. This is considered to be a high impact. Pavement life would be reduced 0.7 years for Route 1A. This is considered to be a moderate/high impact. The roadway maintenance cost would require an additional pavement overlay of $51,625 and local/primary roadway reconstruction, and pavement overlay on the remaining would be $51,625.

The first of two planned trucking routes to the proposed Malden site via Route 1 would require the repair of two bridges to handle the increased truck traffic to the site. The second planned trucking route to the proposed Malden site via Route 1A to Route 60 to Route 1 would require the repair of two bridges to handle the increased truck traffic to the site.

The total cost would be about $10.7 million for the enforcement of routing restrictions as presented for the Bedford disposal site.

Land Use And Social Impacts. The site is surrounded on the north, south, and west by residences, including some condominium development. However, this development appears to be reasonably well buffered by forest, open space, and Route 1.

Relocation Impacts. This site has been used as an active quarry since 1885. The business operating on the site is Rowe Contracting Company of Revere. A relocation plan would be prepared for the business, and it would be entitled to relocation assistance benefits from the project if this area is acquired for use. It would be difficult to identify relocation sites for this business in close proximity to the Boston area.

Air Quality Impacts. Peak year operation for this site is projected to produce emissions equivalent to 7 tons of non-methane hydrocarbons and 24 tons of oxides of nitrogen, regionally.

Transportation Noise Impacts. There are residential condominiums on Lynn Street east of the site entrance. Another noise sensitive receptor is a nursing home on Lincoln Avenue, about 0.5 km to the east of the site. However, noise from truck traffic should not be an impact.

Predicted Noise Impacts During Fill Operations. Three distinct phases of fill operations (site preparation, spreading of material, capping), each requiring different assemblages of equipment, have been identified. As noise characteristics differ for operations in each of these phases, noise levels have been estimated separately by operation phase. The methodology for determining noise levels and impacts were described for the Bedford site.

Existing daytime noise levels were measured in June 1988 for MWRA (MWRA Residuals Management Facilities Plan, Volume 2, Landfill Sites, Black & Veatch, February 1989) at noise sensitive receptors close to the quarry site. At two locations closest to the quarry, noise levels ranged from L_{eq} = 52 to 59 dBA approximately 200 feet from the quarry edge and from L_{eq} = 57 to 58 dBA approximately 100 feet from the quarry edge. At least one residence at the latter location was exposed to the indicated levels of noise associated with the quarry operations. No nighttime measurements were taken.

Therefore, the predicted noise level of L_{eq} = 80 dBA for phases 1 and 2 at 600 feet distance from the site boundary and for phase 3 at 400 feet from the site boundary would indicate increases of more than 20 dBA during the daytime. These increases could be substantially more at night. There are seven residences within 100 feet of the site boundary, approximately 30 residences within 400 feet, and over 100 residences within 600 feet of the site boundary. Specifically, impacts from phase 1 and 2 would occur southwest and northwest of the site. Impacts from phase 3 would occur northeast of the site, and impacts from phases 1, 2, and 3 would occur north of the site.

Hydrologic Impacts. The quarry has been actively mined since 1885 and currently has significant vertical cuts. The quarry operations have removed the original soil formations, exposing bedrock. Adjacent surface water located within 2 kilometers of the site include Towners Pond, Swains Pond, Long Pond, Fiske Brook, Seaplane Basin, Pines Creek, Diamond Creek, and several unnamed ponds. There are two closed landfill/dumps located near the site. According to previous reports, there are no on-site wells and no wells or water supply reservoirs within 2 kilometers of the site.

Groundwater samples collected in December 1988 for MWRA studies (MWRA Residuals Management Facilities Plan, Minor Residuals Landfilling, Volume II, by Black & Veatch, February 1989) indicate elevated levels of volatile organic compounds leaching from the northwestern fringe of the site. Further study of the possible source and extent of contamination at the site would be required and implementation of remedial measures would be required prior to use of this site for materials disposal. This could result in substantial delays should this site be acceptable for project use.

Hydrologic conditions at the site are expected to be governed primarily by impacts of manmade alterations to the site. Development of the site would present unique design requirements, such as preparing the existing rock surface, open joints, fissures and cracks in the rock as a part of controlling underseepage. In an attempt to prevent leachate from entering the groundwater and draining to the surrounding bodies of water, a double liner and underlying drainage system would be installed. Because of the shallow groundwater, the quarry floor would have to be provided with a thick natural liner, a drainage layer, and a leachate collection system.

Visual Impacts. The excavated material would essentially fill the existing quarry. Views of the landfilling operation would be screened from surrounding existing residential areas by existing wooded areas. However, the operation would be visible to vehicles on Route 1.

Summary.

- Substantial noise impacts to surrounding residences would occur through all phases of the project. Impacts of the landfill operation would likely preclude the use of this site on a 24-hour basis. Potential for sound buffering could be a consideration.
- Loss of 4 acres of inland wetlands.
- Leachate into site could require studies and remedial measures.
- Difficulties would exist with the prevention of leachate from entering the fissured rock and contaminating groundwater and surrounding bodies of water.

- Use of this site would require relocation of the existing quarry business.
- This site would not meet the DEP landfill criteria, because of occupied residences within 500 feet.
- Based on the above analysis, use of this site is not recommended because it is neither available nor logistically workable given its failure to meet DEP landfill criteria, because existing technology is not available to ensure the integrity of the groundwater through the fissured bedrock, and also because of the environmental impact to adjacent residences.

4.8.5(d) Site WEY13 (Weymouth)

Site Description. The site in Weymouth is an active quarry with some dumping occurring on the periphery as evidenced by discarded and rusting machinery. The site is adjacent to Route 3, although access to the site is off Pleasant Street (Figure 4.21). Automobile travel time from downtown Boston is approximately 25 minutes during off-peak periods at a distance of 18.6 miles. There are gravel pits located northwest, north, northeast, and south of the site. Adjacent to the site is Old Swamp River, Plymouth River, Whitmans Pond, and Whortlberry Pond. The Abington-Rockland Reservoir is located in the general vicinity, southeast of the site (upgradient). The disposal plan for Weymouth would allow placement of approximately 3.9 million cubic yards of material, of which 2,749,000 cy would be project material, the remainder being imported for the landfill closure.

Aquatic Resources. The limits for the footprint of this landfill were determined by maximizing the landfill capacity while avoiding aquatic resource areas considered to be the most valuable (Figure 4.40).

Inland Wetlands: Such areas include the Atlantic white cedar wetland located on the northern edge of the property and the wetlands adjacent to the Plymouth River along the western edge of the property. The wetlands which would be impacted are, for the most part, areas which have been disturbed by gravel pit operations. Approximately 12.2 acres of wetlands and 5.4 acres of open water would be filled with this footprint. No direct impacts to the Plymouth River would occur.

Nontidal Waters: Clearing and grubbing of the site would result in loss of some soils until grading has progressed to where control of all runoff has been achieved. Runoff would be collected at several locations and directed to sedimentation basins that would remain after construction. Proposed runoff controls should minimize the impacts of suspended solids on the receiving waters. There would still be instances and locations on the site where the initial control of runoff and erosion would be difficult.

Chemical Characteristics. Suspended particulates and turbidity in the Plymouth River and on-site tributaries would be elevated during the construction process. A detailed sedimentation and erosion control plan would have to be implemented to restrict erosion to the maximum extent possible.

Hydrodynamic Impacts. The reduction of infiltration into the site would result in a small reduction to base flow contributions to the Plymouth River and its tributaries. However, total runoff might increase slightly.

Five percent of the site is within the 100-year floodplain.

Traffic/Transportation Impacts. Daily truck traffic on I-93 would likely increase a maximum of 9 percent. This would be a low impact. Daily truck traffic on Route 3 would likely increase a maximum of 20 percent. This would be a low impact. Daily truck traffic on Route 53 would likely increase a maximum of 259 percent. This would be a very high impact. Pavement life could be reduced 0.3 years for Interstate I-93. This would be a moderate to high impact. Pavement life for Route 3 could be reduced 0.7 years. This would be a moderate to high impact. Pavement life could be reduced 9.5 years for Route 53. This would be a very high impact.

The planned trucking route to the proposed Weymouth site via I-93 to Route 3 to Route 228 to Route 53 would require the repair of three bridges to handle the increased truck traffic to the site. The roadway maintenance cost would require an additional pavement overlay of $227,384. Local/primary roadway reconstruction and pavement overlay on the remaining would be $750,881.

The enforcement of routing restrictions would cost $10.7 million for the excavation of all materials to be excavated from the project as described under the Bedford site.

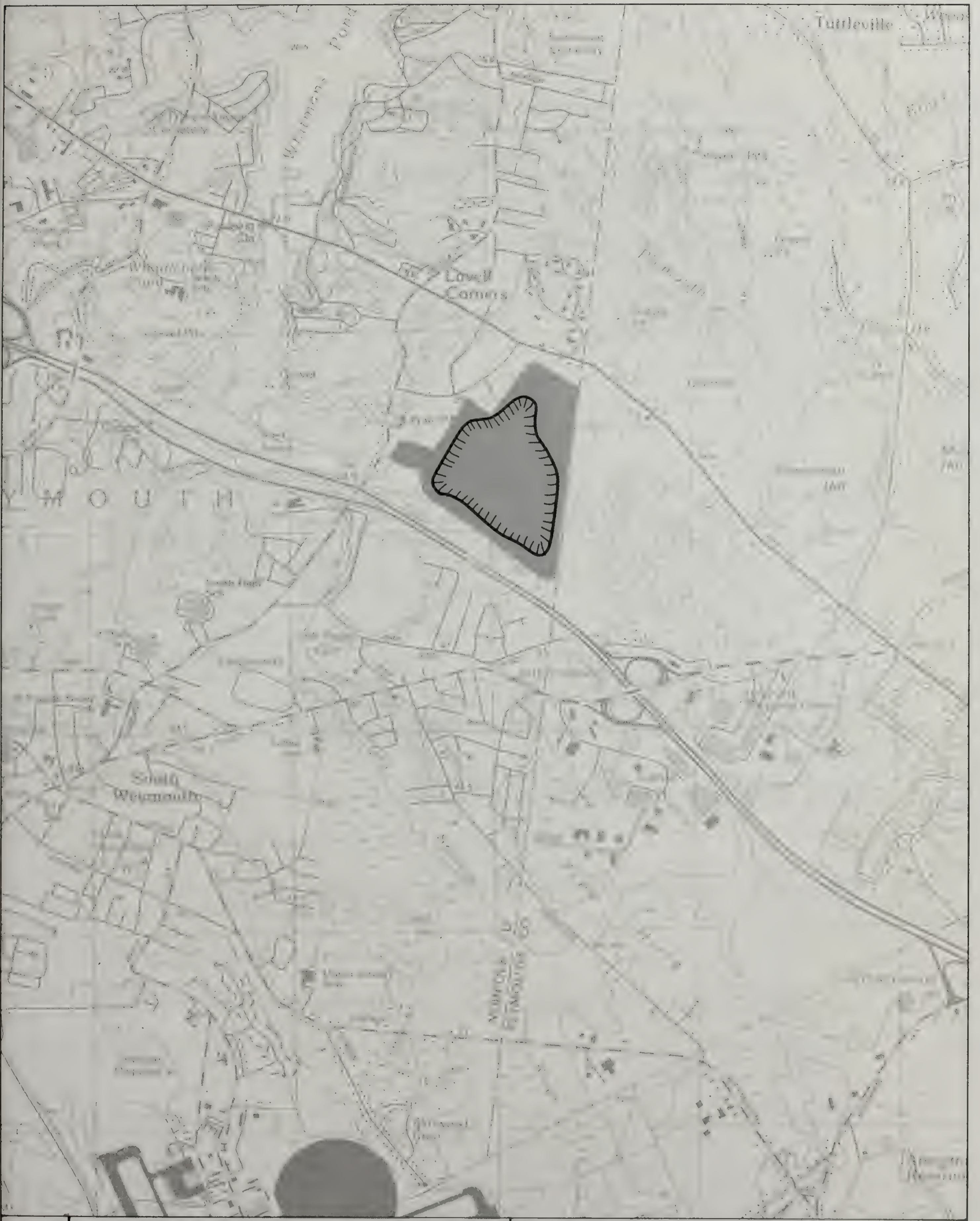
Land Use And Social Impacts. Surrounding the site are a few light industrial areas, and there is some residential and commercial development on the approaches along Whiting and Pleasant Streets. The Pratt School is also adjacent to the site.

Relocation Impacts. Part of the site is an active quarry operated by Bates Brothers. If the site were acquired for material disposal, this business would be entitled to relocation assistance benefits, and a relocation plan would have to be prepared. It would be difficult to identify relocation sites for this business in close proximity to the Boston area.

Air Quality Impacts. Peak year operation of this site is projected to produce emissions equivalent to 9 tons of non-methane hydrocarbons and 50 tons of oxides of nitrogens, regionally.

Transportation Noise Impacts. Access to this site is through residences along Whiting and Pleasant Streets. To the northwest of the site is the Pratt School. Noise level increases of up to 5 dBA over the existing ambient would be expected. Along all the other segments, increases in noise level would be less than 1 dBA and would not be perceived as an impact. Twenty-four-hour operation would not be possible because of the proximity of noise sensitive receptors to the site access routes.

Predicted Noise Impacts During Fill Operations. Three distinct phases of fill operations (site preparation, spreading of material, capping), each requiring different assemblages of equipment, have been identified. As noise characteristics differ for operations in each of these phases, noise levels have been estimated separately by operation



FIGURE

4.40

Site WEY13: Landfill Footprint

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 .5 MILES

phase. The methodology for determining noise levels and impacts was described for the Bedford site.

Substantial noise impacts during the operation of the Weymouth landfill are not predicted to occur.

Public And Private Use. There are several mapped public water supply sources near the site. The site is located in subdrainage basin SS1, with apparent drainage occurring to the north along the Plymouth River into Cushing Pond. The mapped aquifers in the site area are either LL1 or L1, stratified drift formations with relatively low well yields (generally less than 100 gallons per minute per well).

There are several public water supply wells located northwest and southeast of the site. Most of these wells are active, with one being a reserve well and one apparently not in use. There are no known Zone II delineations for any of these wells.

Soil Conservation Service survey data indicate that the predominant soil types at the project site are Hollis and Whitman series soils. Rock outcrops would also be anticipated. Soils in both of these series are associated with compact glacial till formations, high local seasonal groundwater, and relatively shallow depth to bedrock. These characteristics normally limit landfill applications, although the permeability and hydrogeologic characteristics of the subsurface soils is characteristic of well draining (non-transmissive) soils.

Floodplain Impacts. Five percent of the site is within the 100-year floodplain.

Visual Impacts. The excavate would fill the existing quarry and would be viewed from surrounding industrial development as an approximately at-grade large grassy area.

Summary.

- Approximately 12.2 acres of wetland and 5.4 acres of open water would be filled.
- Several public water supplies are located near the site.
- Unacceptable transportation noise impacts would restrict access to the site; 24-hour operation would be very unlikely.
- There are substantial transportation impacts.
- Use of this site would require relocation of the existing quarry business.
- This site would not meet the DEP landfill siting criteria because of the wetlands on site.
- Based on the above analysis, use of this site is not recommended, because it is neither available nor logistically workable given its failure to meet DEP landfill criteria, because existing technology is not available to ensure the integrity of the groundwater, and also because of substantial adverse environmental impacts including the filling of wetland and open water, noise impact, and the potential impacts from use of this site.

4.8.5(e) East Brookfield Site

Site Description. The site in East Brookfield is located to the southwest of the intersection of Route 49 and West Main Street (Route 9) (see Figure 4.26). Approximately half of the site is located in East Brookfield and half in Spenser. Travel time from downtown Boston is approximately 1.25 hours at a distance of 66.8 miles. There is no apparent direct access into the site, although it abuts Route 49 and is in close proximity to Route 9. A Conrail right-of-way borders the southwestern edge of the site.

The disposal plan at East Brookfield allows for the placement of approximately 3.6 million cubic yards of material, of which 2,668,000 cy would be material from the project, and the remainder would be imported for the landfill closure system.

Aquatic Resources. The footprint limits of this landfill were determined by maximizing the landfill capacity while avoiding aquatic resource areas considered to be most valuable. This includes the floodplain forest on the western edge of the property, the vegetatively diverse portions of the wetland along the railroad (including the onsite pond) and the northwestern wetland which includes some of the wetter areas on site that support a somewhat unusual *Sphagnum* mat.

Nontidal Waters: No impacts to the Sevenmile River or the on site pond would occur.

Chemical Characteristics Of Nontidal Waters: Suspended particulates and turbidity in the Sevenmile River and the natural pond would be elevated during the construction process. It is assumed that a detailed sedimentation and erosion control plan would have to be implemented to restrict erosion to the maximum extent possible. There would still be instances and locations on the site where the initial control of runoff and erosion would be difficult. Clearing and grubbing of the site would result in loss of some soils until grading has progressed to where control of all runoff could be achieved. Runoff would be collected at several locations and directed to basins that would serve as sedimentation and infiltration lagoons during and after construction. The East Brookfield site is large enough that runoff control should be effective.

It is assumed that leachate from within the landfill would have to be collected and treated to meet a water quality standard prior to discharge, thereby minimizing chemical impacts to water quality.

Inland Wetlands: Wetlands which would be impacted are, for the most part, forested wetlands typical of the region. A total of approximately 20.2 acres of wetland filling would occur with this footprint (see Figure 4.41).

Hydrodynamic Impacts. There would be small hydrodynamic impacts from use of the site. The reduction of infiltration into the site would result in a small reduction of base flow contributions; however, total runoff may increase slightly. Long term water level changes to the pond would not be anticipated because the site forms a small portion of the pond drainage system.

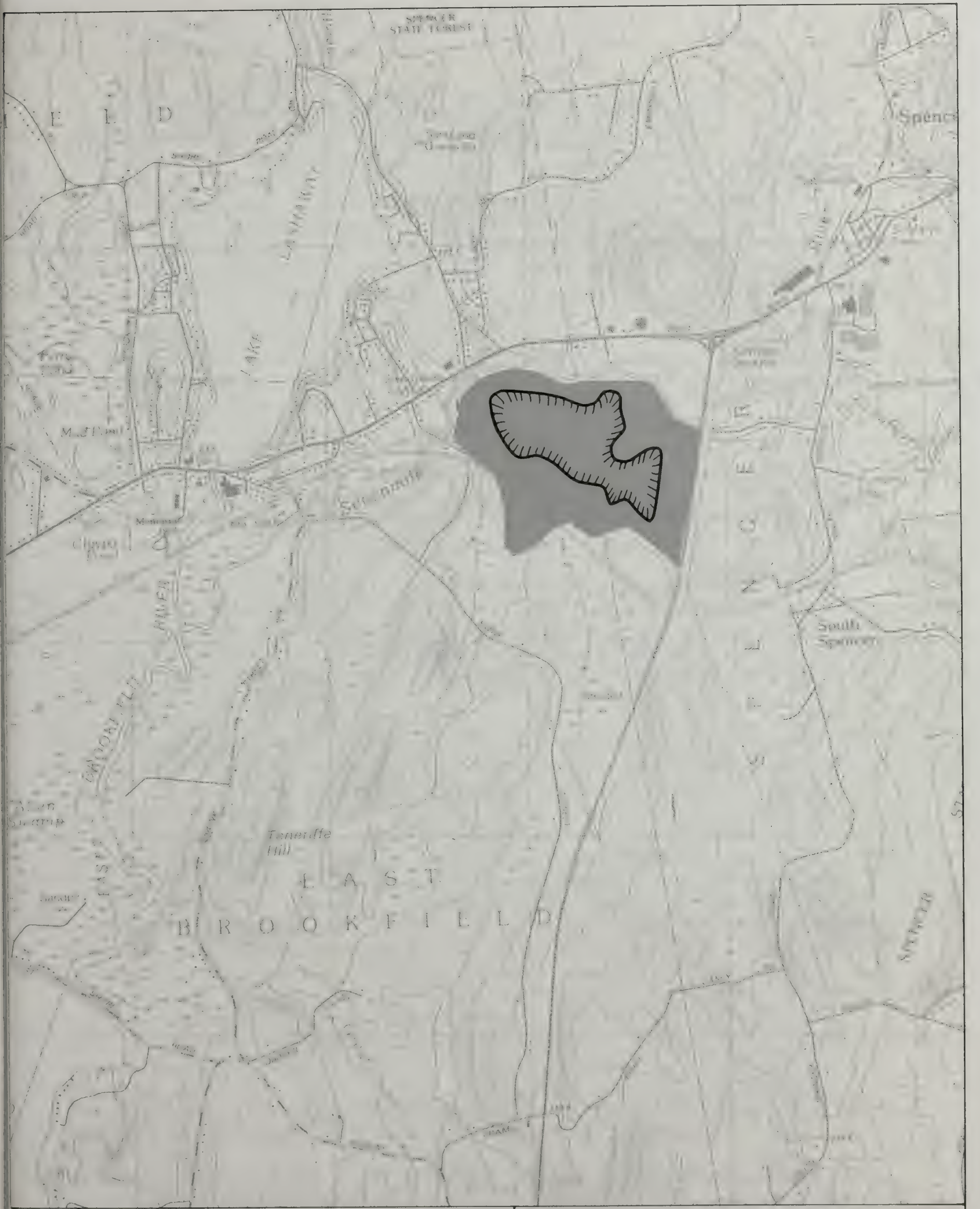


FIGURE 4.41

East Brookfield Site: Landfill Footprint

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Terrestrial Habitat and Wildlife. East Brookfield is generally covered by upland vegetation. No drainage channels are apparent, but about 90 percent of the circumference of the site is adjacent to aquatic resources.

The disposal site has been designed to avoid the more vegetatively diverse wetlands found on site. As a result, wetland vegetation type and interspersion would not be substantially reduced. However, approximately 20.2 acres of wetlands would be lost, mostly in forested areas. Some upland forest and open field communities would also be lost. These areas would be replaced with a uniform grass community.

The reduced vegetative diversity of the site would likely result in lower wildlife diversity and abundance. The remaining wetlands would still provide wildlife habitat. However, these areas would be subject to disturbances during construction, and following construction the loss of adjacent habitat would be reflected in a loss of wildlife that currently use the wetlands. As an example, larger mammals such as deer, which could conceivably continue to use the undisturbed wetlands, may no longer be present on site because of lost upland forests. Additionally, as the site is currently somewhat isolated from adjacent habitat by the presence of the railroad tracks, Route 9, and Route 49, it is less likely that larger mammals which require larger habitat areas would be able to supplement the lost habitat on adjacent parcels.

Wildlife use of the Sevenmile River and pond would not be directly impacted. However, wildlife use of the adjoining uplands and wetlands would be reduced because of the land use changes. These changes would likely result in reduced wildlife use of the River and pond. However, the maintenance of a wooded buffer zone along the pond edge would minimize these impacts. Construction activities would also cause short-term disturbances to wildlife use of the River and pond.

Traffic/Transportation Impacts. The primary advantage of this site is the absence of sensitive development in immediate proximity to the site and the presence of a truck route. However, its distance from Artery/Tunnel construction would result in higher trucking costs than other disposal alternatives.

Daily truck traffic on Interstate I-90 and I-84 would likely increase a maximum of 23 percent. This would be a low impact. Daily truck traffic on Route 20 would likely increase a maximum of 104 percent. This would be a very high impact. Daily truck traffic on Route 49 would likely increase a maximum of 104 percent. This would be a very high impact. Pavement life would be reduced 0.4 to 0.9 years for Interstate I-90 and I-84. This would be a moderate/high impact. Pavement life would be reduced 3.8 years for Route 20. This would be a high impact. Pavement life would be reduced 3.8 years for Route 49. This would be a high impact. The roadway maintenance cost would require an additional pavement overlay of $402,960 and local/primary roadway reconstruction. Pavement overlay on the remaining would be $1,500,460.

The enforcement of routing restrictions would cost $10.7 million for the excavation of all materials to be excavated from the project as described under the Bedford site.

As noted in Figure 4.41, rail access is available at the East Brookfield site and use of this mode of transport would mitigate the above impacts associated with trucking material to the site. However, in Section 4.2.2(a), handling of excavated material by rail was evaluated and found to be impracticable.

Land Use and Social Impacts. The site is presently wooded and undeveloped. To the northwest of the site is residential development. West Main Street, north of the site, has a mixture of low density commercial and residential development. If well buffered with existing woods, impacts to the surrounding area could be minimized.

Relocation Impacts. The site is currently vacant land. No businesses are operating on the property; therefore, there would be no relocation impacts resulting from the use of this property for material disposal.

Air Quality Impacts. Peak year operation of this site is projected to produce emissions equivalent to 22 tons of non-methane hydrocarbons and 150 tons of oxides of nitrogen, regionally.

Transportation Noise Impacts. The site is reached by roadways carrying large volumes of truck traffic, except for the last segment, where the access is through West Main Street. There are noise sensitive receptors along either side of the last segment (West Main Street) which may limit access to the site. The predicted increase in noise levels is 4 dBA over the existing level in areas near Main Street. This would be subjectively noticed as an impact. Increases in the other segments would be 2 dBA and less. This site would not be able to operate on a 24-hour basis.

Predicted Noise Impacts During Fill Operations. Three distinct phases of fill operations (site preparation, spreading of material, capping), each requiring different assemblages of equipment, have been identified. As noise characteristics differ for operations in each of these phases, noise levels have been estimated separately by operation phase. The methodology for determining noise levels and impacts was described for the Bedford site.

Substantial noise impacts during the operation of the East Brookfield landfill are not predicted during phases 1, 2, or 3.

Public And Private Use. U.S.G.S. topographic mapping indicates that the site has a hilly topography with scattered wetlands. Adjacent surface water bodies include Lake Lashaway, Sevenmile River, Brookfield River, Cranberry River, and miscellaneous ponds and streams. The mapping also indicates sand and gravel pits north of the site, a sandpit south of the site, and a gravel pit east of the site.

Approximately 0.75 to 1 kilometer north-northeast of the site is a verified surface impoundment and dump/landfill. There is an auto salvage (dump) yard about 0.75 km south of the site and a reported open dump about 1.5 kilometers west southwest of the site. A sewage disposal plant is located northeast of the site.

The site is located in the Chicopee River Basin, in the CP218 subbasin. Flow is typically to the west. There are two active water supply wells located 0.75 and 1.5 kilometers from the site. Technical assistance for Zone II delineation has been requested or provided with reference to at least one of these wells.

Based upon the limited information available, it appears that possible impacts may result in groundwater, surface water, and/or public water supplies adjacent to this location. Although the proposed landfill would be lined, the presence of municipal water supply wells downstream of the site, may require additional protective measures to be taken to ensure that leachate does not enter the groundwater system. Part of the site may be within an area under the influence of downstream municipal water wells. A Zone II delineation study identified the extended Zone II boundary as potentially reaching the site boundary.

Floodplain Impacts. Five percent of the disposal site area is within the 100-year floodplain.

Visual Impacts. Filling of this site would result in a hill or several hills approximately 50 feet above grade. The grass covered hills would be partially screened by the surrounding wooded area. There is no development immediately adjacent the site.

Summary.

- o Approximately 20.2 acres of wetlands and some adjacent upland habitats would be lost.

- o Two active water supply wells are located near the site and Zone II delineation has been requested. An extended Zone II delineation may reach the site.

- o The site would not be able to operate on a 24-hour basis.

- o This site would not meet the DEP landfill siting criteria for wetlands and possible Zone II delineation.

- o Use of this site is not recommended, because it is neither available nor logistically workable given its failure to meet DEP landfill criteria, because existing technology is not available to ensure the integrity of the groundwater, and also because of adverse environmental impacts, including the filling of wetlands and the possible adverse effects on active water supply wells.

4.8.5(f) Governors Island Flats

Site Description. This site is located in a shallow area of the Harbor, bounded by Logan Airport to the north and President Roads and the Main Ship Channel to the south and west (see Figure 4.29). Approximately 25 percent of this area consists of tidal flats, while the remainder ranges in depth from one foot below MLW to 27 feet below MLW. There is a 24-acre area within the bulkhead line that defines the proposed limits of construction into the Harbor. The fill area would have a top elevation generally equal to that of Logan Airport.

Aquatic Resources. The Governors Island Flats site has a capacity of 16 million cubic yards; 9.3 million cubic yards would be disposed at this site. The footprint for the proposed fill is shown in Figure 4.29.

Use of the Governors Island area would require the filling of approximately 287 acres of open water and intertidal flat involving the total loss of 40 acres of economically viable shellfish beds as well as the ecological resources associated with them. It would not involve direct filling of the adjacent salt marsh. However, indirect impacts could impact that area.

Use of the Governors Island site would produce short and long term impacts. The short term impacts would be directly associated with the dike construction and filling process, and the long term impacts would be associated with changes in hydrodynamics.

The following impact discussions are for the resource areas that are present at the site: tidal waters, coastal mudflats, and coastal wetlands.

Based on the NOAA Navigation Chart and aerial photographs, Governors Island Flats contain 24 acres of salt marsh and approximately 105 acres of intertidal mudflats. This area was calculated from a 1984 aerial photograph and field verified in June 1987 by Jason M. Cortell and Associates.

Tidal Waters: Filling of Governors Island Flats would require the construction of a dike to contain the fill materials. The dike would be of rock construction with riprap for shoreline protection. It is assumed that a key trench would be required for a stable dike foundation. This would require the dredging of mud, clay, till, and sand. It is assumed that these materials would be suitable for disposal at the MBDS.

Dredging would produce short term increases in suspended solids and turbidity. During dredging, adjacent resource areas could be protected by the deployment of silt curtains. Dewatering the area within the dike during filling would also increase suspended materials. Suspended solids within the dike that are contributed from the filling process could be controlled by the incorporation of sedimentation basins within the fill and/or the use of mechanical clarifiers. The increased suspended solids from the construction process should not be of a magnitude that would substantially reduce water quality at adjacent areas.

Changes to water quality would be associated with short term increases of suspended solids. Because of the possibility of reduced flushing in the remaining area of Governors Island Flats, there could also be local changes in water quality from stormwater outfalls along the periphery of Logan Airport.

There could be minor impacts to fish during dredging and construction, and fish habitat would also be displaced. Shorebirds that use the mudflats would be displaced. It is assumed the area would be grassed over and maintained in a manner that is consistent with airfield operations at Logan Airport. There would be no attempt to attract or support wildlife.

Construction of the Governors Island dike and fill would result in long term changes in hydrodynamics of the area. While hydrographic modeling has not been conducted to determine the extent of the impacts, shoaling would most likely develop, particularly along the east and north sides of the dike. The dike could also alter the tidal flushing affecting local and adjacent sediment conditions. The filling would have negligible impacts on flooding.

Coastal Mudflats: About 105 acres of intertidal flats would be impacted as the result of changes in tidal current patterns and sediment deposition. This includes 4 acres of soft-shelled clam beds.

Changes in hydrodynamics could alter substrate distribution and the abundance and type of species that inhabit sediments. These impacts would be localized changes. However, there could be a loss of additional productive soft-shelled clam flats.

Conversely, the containment dike structure would improve the natural resource values by providing rocky intertidal habitat. The void spaces between rocks within the dike would provide excellent and stable habitat for organisms such as worms, mollusks, crustaceans, fish, marine algae, and other marine forms.

Coastal Wetlands: About 24 acres of salt marsh between the tidal flat and rocky shore would be directly impacted. The adjacent salt marsh could be indirectly impacted from siltation arising during construction or from altered current patterns following construction.

There would be no impacts to vegetation as there are no stands of rooted plants in the area to be filled.

Traffic/Transportation Impacts. Truck access to the site would be along airport service roads, and paved access into the site would need improvement. A tunnel under one runway end would have to be built to eliminate truck/aircraft interference. The depth of the access channel is sufficient for barge transport, and barges should not interfere with shipping or recreational boating. However, barge unloading cranes might interfere with aircraft operations, depending on their location with respect to runway approaches.

Deck barges would be used to transport excavated material to Governors Island Flats. Barges would follow the Boston Main Channel out of the Inner Harbor and then head directly to Governors Island Flats. Barges traveling to Governors Island Flats would not affect navigational safety conditions in the Harbor, and the trip to the site would take approximately 1 hour.

Transporting the 9.3 million cy of material to Governors Island Flats would require 7,500 barge round-trip movements. The disposal operation would be active for seven years. During the peak period, a maximum of 15 barge trips (30 round-trips) could be expected on a daily basis. Barges could be unloaded at Governors Island Flats either by truck or by using a slurry method. Using the slurry method, water would be pumped onto the barges, and then the moistened material would be pumped directly into the disposal site. Using the trucking method, it would take approximately 11 hours to unload a barge, and one barge unloading facility could be used for the duration of the project. Unloading using the slurry method would take considerably less time; a number of different docking locations would be used as work progressed.

Land Use And Social Impacts. The site is now vacant and is zoned for waterfront industrial use. There are no development plans for the site. Disposal would be compatible with adjacent airport land use.

Relocation Impacts. None.

Economic Impacts. The 105 acres of mudflats are productive shellfish harvesting areas. They are open to commercial shellfish harvesting by Master Diggers. During June 1987, JMCA sampled the shellfish beds in the flats at 20 locations. An average of less than one soft-shell clam per cubic foot was found (range 0-5 per square foot), with 67 percent being seed class and 33 percent of legal size. No intermediate sizes were found. Although of relatively low density, DEP and DMF report that the beds quickly repopulated after several seasons of rest.

Blue mussel beds that contained 10 to 15 percent live organisms were observed in the area. Filling of the area would eliminate any economic use of the shellfish beds.

Air Quality Impacts. Trucks and/or barges used to reach this site would have insignificant impacts on air quality because of the very short travel distance.

Transportation Noise Impacts. No sensitive noise receptors are located along routes to the site or in the vicinity of the site.

Public And Private Uses. No public water supply wells have been identified on the site. No directional flow of watershed drainage has been shown. Surface water quality around the site is rated SB.

The saltmarsh is a locally significant food source.

Threatened Or Endangered Species. No endangered or threatened species have been reported or observed on Governors Island Flats.

Visual Impacts. A wetlands area at the edge of Logan Airport would be filled to the same grade as the airport. No visual impacts would result.

Summary.

- The loss of the natural resources of this site is important in view of their contribution to the Harbor environment at present and their potential after the Harbor Clean-up Project has been implemented.
- 40 acres of economically viable shellfish beds would be lost.
- 287 acres of open water would be filled.
- Rocky intertidal habitat would be provided in the containment dike structure.
- Use of this site is not recommended for materials disposal because of the adverse environmental consequences resulting from the loss of shellfish beds and other natural resources.

4.8.5(g) Hull Bay

Site Description. The Hull Bay disposal area is located approximately 1,000 yards south of Windmill Point, which is at the northwestern extremity of Hull (see Figure 4.30). The site is approximately 500 acres in area. Depth soundings taken in this area show water depths of 70 feet below mean low water (MLW). The Hull Bay disposal area has previously been used for dumping, but it is now inactive. The site is located about 3 hours by barge from marine transfer stations in Boston.

The Hull disposal site has an area of approximately 500 acres and a maximum depth of -70 feet mlw. Assuming the site was filled to a -50 ft depth, which would be equal to that of surrounding waters, the site would have a capacity of 0.8 million cubic yards.

Aquatic Resources. One aquatic resource, tidal waters, is identified for this site.

Tidal Waters: It is assumed that only those materials that are acceptable for ocean disposal would be disposed at the Hull site. Under this assumption, and considering tidal current velocities, dispersion would be high. As previously discussed in Section 4.8.3(a), Ocean Disposal, material containing floatables could not be disposed at this site. Impacts mentioned in the above section would be similar but of far greater magnitude because of the closeness of this site to marine recreational areas and users.

Water is classified as SB (suitable for protection and propagating of marine life and wildlife and for shellfish harvesting). Depending on the grain size of materials that would be dumped at the Hull Bay site, the levels of suspended solids would vary. Fine sediment particles such as silts and clays would produce more suspended solids than would coarser materials. The turbidity plume would be spread to most parts of Hull and Hingham Bays on the flood tide and out into Massachusetts Bay during the ebb tide. For the site itself, the impact would be of short duration because of high current speeds.

There are no vegetation on the site that would be impacted, and it has been assumed that there are no shellfish resources present. There would be a loss of invertebrates inhabiting the site. Depending on the particle size of disposed materials, recolonization could be relatively quick with coarse and stable materials or slower with finer sediment particles because erosion would cause a continual change in substrate texture.

Fisheries impacts could be more substantial. The site is part of the winter flounder spawning area and disposal would have to be curtailed during the spawning period to protect adults, eggs, and fry. Depending on the level of suspended solids generated by disposal, mortality of young fish in the Bay could occur. Wildlife impacts would only be temporary and occur during disposal.

Hydrodynamic Impacts. Disposal at the Hull site would produce two levels of hydrodynamic impact. There would be an initial decrease in the depth of the site and local circulation patterns across the bottom. However, unless heavy, non-erodible particles are disposed, currents would transport sediments from the site resulting in a return to near present depths.

The Boston Harbor tidal current charts show that the surface velocity of the maximum spring tides near the site are estimated to be 2.0 feet per second (fps). This is relatively high for a surface velocity, and the velocity at depth may be greater. The direction of the surface current is south-southeast, and it is possible that fine grained material dumped in this area would be transferred to an area of shallows northwest of Bumpkin Island. On the reverse tide, current velocities are recorded at 0.68 fps to the north-northwest. The velocities at the site itself may be somewhat different (lower) but are not known at this time.

Land Use And Social Impacts. The site is adjacent to islands included in Boston Harbor Islands State Park. No long-term land use impacts would result from placement of materials in this area. Short-term disruption of recreational boating activities could result.

Traffic/Transportation Impacts. The depth of the access channel is sufficient for barges. Bottom-dump barges would be used to carry excavated material to the Hull Bay disposal area. Barges would follow the Hingham commuter ferry route, turn north at Rainsford Island and travel directly to the disposal area. It is possible that barges would encounter recreational craft while navigating in Hull Bay, especially during warm weather months. The trip from Boston to the Hull Bay site would take approximately 3 hours.

Given the Hull Bay disposal area's 800,000 cubic yard capacity, 667 barge trips (round trips) would be made to the site. Although a schedule for disposing of materials has not been established for Hull Bay, it can be assumed that all appropriate fill from a designated barge loading facility would be sent to the Hull site until its capacity has been reached. If it is assumed, for instance, that half of the excavated material arriving at the East Boston barge loading facility were suitable for marine disposal, the Hull Bay disposal area would be filled in approximately 18 months.

The Federally maintained channel is about 400 yards to the west and limits the height of the fill. The absence of a silt and clay bottom suggests that high current velocities may be present for some periods of time. Deposited materials could possibly be moved off site into the channel (or as described above).

Air Quality Impacts. There would be minor short-term impacts from the presence of barges, but no sensitive receptors are found in the area.

Transportation Noise Impacts. Minor short-term impacts due to presence of barges, but no sensitive receptors are found in the area.

Summary.

- o Use of this site would result in the dispersion of project materials from this site by high tidal energy of the area.
- o Any disposal at this site should be limited to the disposal of a small quantity of high quality, heavy materials.
- o Use of this site is not recommended because of adverse environmental consequences resulting from movement of deposited materials.

4.8.5(h) Logan Airport North.

Site Description: This site is located off the northern edge of Logan Airport (see Figure 4.32). Constitution Beach is to the northwest, a residential area of East Boston is to the north, and Winthrop is to the east. Marine charts show that the maximum depth of this area is 29 feet below mean low water. Depth soundings performed in 1987 generally confirm this information. The area was created during the expansion of Logan Airport, by hydraulic dredging.

Aquatic Resources. One resources would be directly affected by disposal at this site: tidal waters. Additionally, coastal mudflats and wetlands may be indirectly impacted.

Tidal Waters: Filling of the area could be conducted by bottom dump barges. Suspended solids would be very high for an open water disposal operation without the use of controls on dispersion. Control of suspended solids and turbidity in the area would be difficult because of its "in-line position" between the Logan West site and Belle Isle Inlet to the north. Most likely, it would not be possible to isolate the area during filling and suspended solids would be high because of the small water volume of the site. Not only would solids impact the immediate area, but they would also impact upstream areas such as Logan West and Belle Isle Inlet, as well as downstream areas including Winthrop Bay.

Suspended solids would continue to be high during and following filling until the new sediments are stabilized by heavier consolidated material. Erosion and suspension could last for a number of years and wind generated waves would also increase turbidity levels. The long term impact could be shortened by intentionally stabilizing the new bottom with a layer of sand or similar material.

In addition to suspended solids, if the urban fill from the alignment were dumped at this site, there would also be impacts from floating materials. These materials would wash up on the shoreline and beaches of Logan North and West, Belle Isle Marsh, Winthrop Bay, and possibly other parts of the Harbor and would interfere with fishing, navigation, or other recreational uses.

Filling of the Logan North site would increase tidal flushing by reducing the volume of water below the low water level. The reduced tidal volume would result in a loss of water that is presently available to dilute pollutants. This potentially could increase water contaminants such as bacteria, particularly near Constitution Beach, if flushing does not compensate for the volume loss. Because the filling would take place below mean low water, there would not be any impacts on flood plains.

Direct impacts from the filling would be the loss of 114 acres of tidal water substrate that would be replaced by a new substrate. Depending on the grain size of the surface materials that result from the filling, various benthic communities could colonize the site.

There would be a loss of fishery habitat from the filling. This could result in a reduction in local fish populations. The species composition may not appreciably change.

Coastal Mudflats: Use of this site would involve a temporary impact on 114 acres of potentially productive marine resources. However, the intertidal waters in the vicinity of this site are presently closed to any harvesting (including Master Diggers).

Because of the inability to contain suspended solids, invertebrate resources including shellfish could be impacted by disposal operations as well as a long-term problem with continued turbidity. There would be temporary impacts to wildlife using the flats (such as shorebirds) during filling as the result of suspended solids, turbidity, and floating materials.

Coastal Wetlands: Marsh adjacent to this site could be affected by continual suspension and hydrologic changes associated with lost tidal volume.

Traffic/Transportation Impacts. Use of the site for barge dumping would require minor dredging. There are no long-term transportation impacts. Dump barges would be used to transport excavated materials to the Logan Airport North site. The site is located approximately 1 mile from most barge loading facilities. However, difficult navigational conditions near Chelsea Point result in an approximately 3 hour transit for barges to the site. In addition, because of shallow waters, it is possible that barges could encounter delays during low tide. Barges could experience additional delays while traveling the channel between Chelsea and Logan Airport, as only one barge can navigate safely through the channel at a time.

A total of 810 barge round trips would be made to the Logan Airport North site, where a total of 1,000,000 cy of material would be disposed. It is estimated that disposal operations at the site would extend for approximately 2 years.

Land Use And Social Impacts. Site filling operations would interfere with recreational boating and use of Constitution Beach. There are no planned developments for the site, and no long-term land use impacts would result from placement of materials in this area.

Bacteria is the largest water quality problem at this site. Because bacteria are a particular problem at Constitution Beach, increases could extend beach closures. If contaminated urban fill materials were disposed at the surface of the site, leaching of contaminants into the water could result in additional health risks.

Floatables in the fill materials (i.e., wood, cinders and coal) would probably wash ashore and be aesthetically unacceptable or would continue to float on the water surface and interfere with fishing, navigation, and recreational users of Boston Harbor.

Air Quality Impacts. There would be minor short-term impacts because of the presence of barges, but no sensitive receptors are found in the area.

Transportation Noise Impacts. There would be minor short-term impacts because of the presence of barges, but no sensitive receptors are found in the area.

Public And Private Use. Aquifer yield on landside is rated L_1. Water in the vicinity of Logan Airport is classified by the Massachusetts Division of Water Pollution Control (DWPC) as SB.

Of concern when filling Logan Airport sites would be the reduction in the capacity of the waters in vicinity to assimilate pollutant loads from the combined sewers and other discharges to these waters from both point and nonpoint sources. The placement of large amounts of dredged and/or excavated materials at the Logan Airport North site would decrease the volume of water available to dilute combined sewer overflows and other sources of contaminated water which empty into Belle Isle Inlet, the area of Constitution Beach, and other parts of Winthrop Bay.

This area supports commercial shellfishing in the subtidal area. No shellfishing is allowed in the intertidal area. The relatively low population of older age-class shellfish and dominance of pollution-tolerant worms suggest that the sediments are seriously degraded. Water quality is generally good (classification is SB).

Threatened Or Endangered Species. No endangered or threatened species have been identified on site.

Visual Impacts. There would be no long-term visual impacts from this option.

Summary.

- There would be impacts to recreational use of Constitution Beach and boating from sediment plumes and floatables.
- Reduction of tidal volume would increase water quality problems related to bacterial concentrations.
- There would be potential impacts to Belle Isle Marsh and Winthrop Bay.
- This site is not recommended for use because of the above adverse environmental impacts.

4.8.5(i) Logan Airport West

Site Description. This area is located adjacent to the Logan Airport North site (Figure 4.32). Constitution Beach is to the north and a large marsh area is to be west of the site. The site is located 2 miles from the East Boston excavation site by truck and 3 hours from marine transfer stations by barge.

The Logan West site is also a submerged borrow pit approximately 30 feet deep at mean low water. It was created during the construction of Logan Airport. Use of the site would involve the filling of the pit to a depth of -15 feet at MLW. This would provide for the disposal capacity of approximately 420,000 cubic yards.

Aquatic Resources. One aquatic resource area, tidal waters, is directly affected by disposal at this site. However, adjacent coastal mudflats and wetlands may be affected indirectly.

Tidal Waters: Filling of the area could be conducted by bottom dump barges. Silt curtains would extend close to the bottom at low water and should be effective in minimizing the spread of turbid water throughout the water column. Because there are no upstream bodies of water that must drain through this site, the curtains should be more effective than they would be at Logan North.

Filling of the area would result in a layer of turbid water on the bottom that would not be containable.

Suspended solids will continue to leave the dump area until the new sediments are stabilized by heavier consolidated materials. This condition could last for a number of years. Wind generated waves would also increase turbidity levels.

Filling of the Logan West site will increase tidal flushing by reducing the volume of water below the low water level. The increase in tidal flushing represents a reduction of water volume presently available to dilute pollutants. This could result in increased contaminant concentrations.

Water uses in the Logan West site are not as sensitive as they are in the Logan North Site (because of the presence of Constitution Beach). Therefore, the reduction of water volume and loss of dilution would not be expected to exacerbate water quality problems. However, if contaminated urban fill materials were disposed at the surface of the site, leaching of contaminants into the water would take place until steady-state conditions were attained, constituting a new health concern. Because the filling would take place below mean low water, there would not be any impacts on flood plains.

Direct impacts from the filling would be the loss of approximately 34 acres of existing tidal water substrate that would be replaced by a new substrate that would recolonize. Depending on the grain size of the surface materials that result from the filling, various ethnic communities could colonize the site. There do not appear to be long term impacts to ethnic resources because of the high recruitment rate associated with those communities.

There would be a loss of fishery habitat, and this could result in a local reduction in fish populations. The species composition may not appreciably change.

Coastal Mudflats: Adjacent shellfish resources could be impacted more by suspended solids during disposal operations than by long-term impacts. If controls on the dispersion of suspended solids were not exercised, smothering of shellfish would be likely because of the high concentration of solids. Similarly, there could also be short-term suspended solids impacts to vegetation in bordering salt marshes and in adjacent waters.

There would be temporary impacts to wildlife such as birds using adjacent mudflats during filling as the result of suspended solids, turbidity, floating materials, and general disturbance of the area.

Coastal Wetlands: There would be temporary impacts to wildlife such as birds using adjacent wetlands as the result of general disturbance of the area.

Traffic/Transportation Impacts. Use of the site for barge dumping would require minor dredging of access channels. There would be no long-term transportation impacts.

Dump barges would be used to transport excavated materials to the Logan Airport West site. The site is located approximately 1 mile from most barge loading facilities. However, because of difficult navigational conditions near Chelsea Point, it would take barges approximately 3 hours to travel to the site. In addition, because of shallow waters, it is possible that barges could encounter delays during low tide. Barges could experience additional delays while travelling through the channel between Chelsea and Logan Airport, as only one barge can navigate safely through the channel at a time.

A total of 340 barge round trips would be made to the Logan Airport West site, where a total of 420,000 cy of material would be disposed. Disposal operations at the site would extend for approximately 10 months.

Land Use and Social Impacts. Filling operations could interfere with recreational boating and the use of Constitution Beach. There are no planned developments for the site, and no long-term land use impacts would result from placement of materials in this area. A limiting factor for filling (reduced depth of about 2 feet) is recreational boat traffic.

Air Quality Impacts. There would be minor short-term impacts because of presence of barges, but no sensitive receptors are found in the area.

Transportation Noise Impacts. There would be minor short-term impacts because of presence of barges, but no sensitive receptors are found in the area.

Public And Private Use. There are no public water supply wells identified. Water in the vicinity of Logan Airport is classified by the Massachusetts Division of Water Pollution Control (DWPC) as SB.

Of concern when filling Logan Airport sites is the reduction in the capacity of the waters in vicinity to assimilate the pollutant loads from the combined sewers and other discharges to these waters from both point and nonpoint sources.

The placement of large volumes of dredged and/or excavated materials at the Logan Airport West site would decrease the volume of water available to dilute combined sewer overflows and other sources of contaminated water which empty into Belle Isle Inlet, the area of Constitution Beach, and other parts of Winthrop Bay. The Logan Airport West site presents all of the same problems as Logan Airport North, and these problems would be aggravated by its even more confined location.

Threatened Or Endangered Species. No endangered or threatened species are identified on site.

Visual Impacts. There would be no long-term visual impacts from this option.

Summary.

- o Impacts to recreational use of Constitution Beach and boating would occur.
- o There would be reduced water volume, potentially increasing contaminant concentrations.
- o There would be potential impacts to nearby aquatic resources from suspended solids.
- o This site is not recommended for use because of the above adverse environmental consequences.

4.8.5(j) Spectacle Island

The impact analysis provided below is based on disposing approximately 9.3 million cy of material on the island. Figure 4.42 illustrates the shape of the proposed island.

Design Of The Site. The design and configuration of the Spectacle Island material containment facility has been based on geotechnical, oceanographic, and environmental considerations, including conformance with the Boston Harbor Islands State Park master plan for the island. The plan states:

> ". . . Spectacle Island will be the last major island available for intensive recreational use. Its location close to shore and its easily understood relationship to the mainland, Thompson and Long Islands, make it a natural candidate to provide the most general introduction to the Harbor, while the other islands serve repeat visitors and develop the Park's themes more specifically.
>
> Whether or not it is developed for park use, Spectacle requires extensive stabilization to mitigate the environmental impacts of the eroding landfill. This will consist of capping the landfill with clay, filling against the eroding slopes, and protecting these slopes with stone revetments. The Plan provides for creation of a salt marsh edge to provide natural treatment for seepage of groundwater. The stabilization project will be most feasible if spoil materials from a major public project such as the Central Artery/Third Harbor Tunnel are utilized."

Figure 4.43 presents the park as envisioned in the DEM Master Plan.

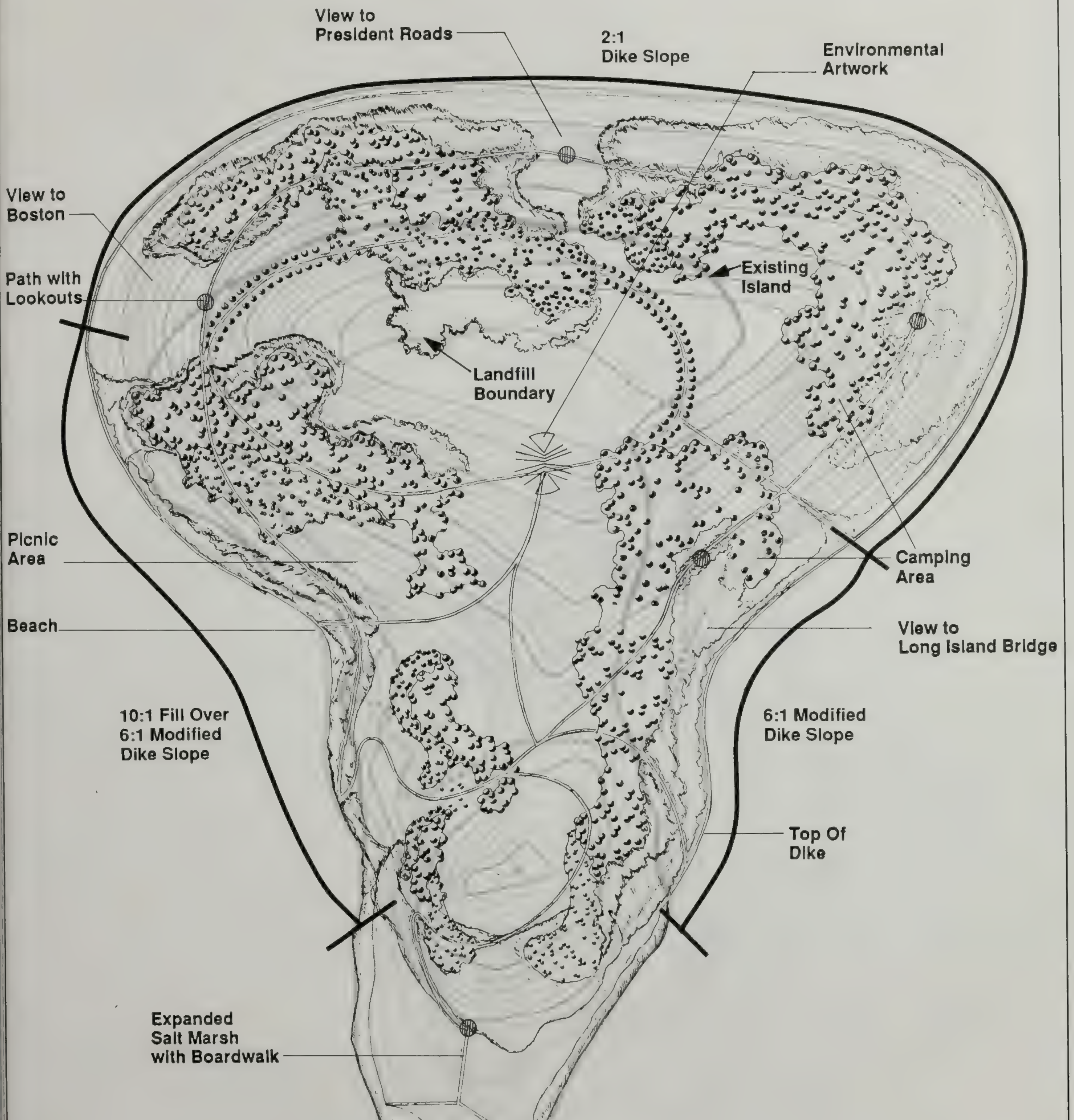
A major component of the facility would be the construction of a perimeter dike that would support the material to be placed on the island and serve as a breakwater against wave action (shore protection). Fill would be placed behind the dike with a sloping surface rising to a knoll. Based on current plans for future use of the island, slopes of both the fill on the island and the containment dikes would be designed to allow use of the island as a park or conservation area.

In order to determine the feasibility of material disposal at Spectacle Island, initial design work was undertaken. To guide the design, a number of goals and criteria were established to address engineering, land planning, tidelands, and environmental concerns. The plan layout, slopes, and height of the disposal area were based on the following factors:

- Poor foundation conditions under the containment dike and the fill slopes should be avoided. Dredging of unacceptable materials, and the need for costly and time consuming foundation strength improvements as an alternative to dredging, should be minimized.

- Disposal of the required volume of excavated materials should be accommodated within as small an area as possible. The perimeter of any containment structure exposed to storm wave action should be minimized. Thereby, the area that would require costly erosion protection would be reduced, and filling of Boston Harbor would be minimized to the fullest extent possible consistent with designing the containment to be suitable for future park use.

- The Federal Aviation Administration (FAA) criteria for structures in proximity to Logan Airport has set the maximum permissible final elevation of Spectacle Island at 150 feet mean sea level (MSL), as measured at the top of trees. The disposal site would result in a final elevation of 140 feet in the northern part of the island. Open, grassy vegetation would be maintained on hilltops to allow harbor views. The high ground at the southern part of the island would remain unchanged from the existing topography.

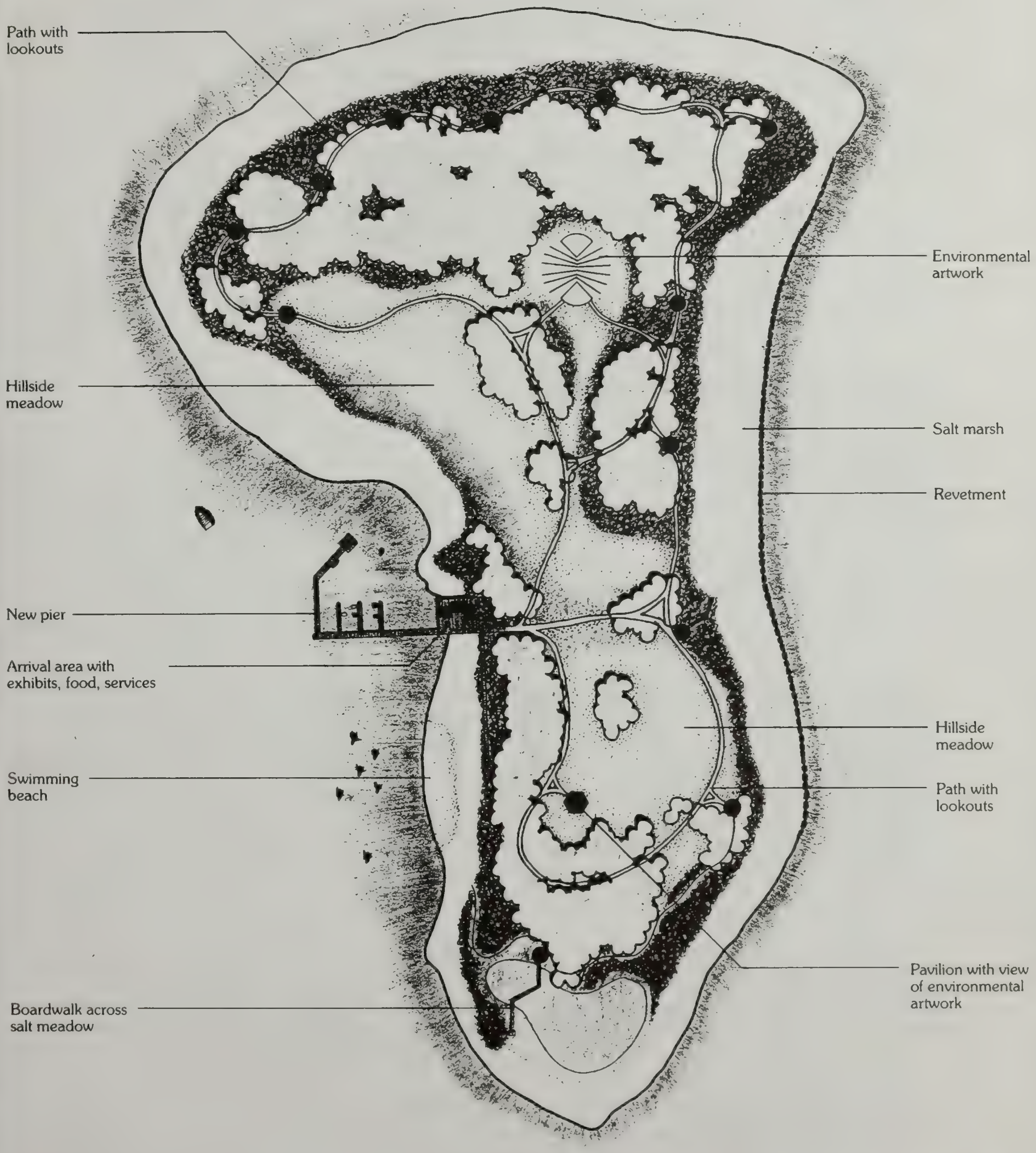


FIGURE

4.42

Proposed Spectacle Island Concept

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R



Source: **Department of Environmental Management 1986**
Boston Harbor Islands State Park Masterplan

FIGURE 4.43 **Spectacle Island Concept Plan**

- Distribution of the fill over the containment area should try to recreate, if feasible, the historic "spectacle" shape of the island.

- A north-south profile consisting of two distinctive peaks should be retained, marking the presence of glacial drumlins.

- The height of exposed riprap rock dike should be restricted to a maximum height of 12 feet above mean sea level unless wave action analysis indicates the need for additional slope protection. The rock would be covered by a vegetation-supported soil layer, reinforced with a geosynthetic mat that could be repaired in the event of erosion from a major storm.

Slopes of the retention dike and fill would be selected on the basis of the following engineering and environmental considerations:

- The excavated materials should be used to provide stability of the retention dike over foundation soils and stability of the final slopes.

- The final slopes of the island should be variable to create a visually interesting appearance, ecologically beneficial habitats, and direct safe access to the water's edge. The slopes should vary from a maximum 5H:1V, to a minimum of 10H:1V. The use of slopes with less than the maximum 5H:1V may be incorporated into the facility design to enhance its suitability as park land. The result of using slopes that are gentler than the maximum is an increase in the amount of filling of Boston Harbor.

- The armor rock required for wave protection should be of appropriate size.

The proposed shape for Spectacle Island is conducive for maintaining and enhancing wildlife, wetland, and aquatic resources. The proposed shape emulates the island's current shape which has resulted from physical processes such as wave action, currents, and subsequent deposition of eroded sediments. Therefore, future areas of sediment deposition should be similar to those currently present. However, dike materials (boulder, rock) would be less subject to erosion and movement than existing substrates. Thus, stable interstices (spaces) would be created, providing locations for sedimentation and colonizing species. The dike and cap also would isolate aquatic resources from contaminants leaching or eroding from the dump site.

On the more sheltered western side of the island, a beach consisting of sand and gravel placed on a 10:1 slope would be provided. On the east side, which is more exposed to heavy seas, portions of the "beach" could be capped by specially selected slab-like heavy rock, individually placed on a 6:1 slope. The north and northeasterly side of the island would have the armor rock placed at a 2:1 slope.

It should be noted that the design would include a mix of slopes for both the perimeter dike and the placement of the fill. These varied slopes would enhance the end use of the island as park land and create a valuable ecological resource. For example, gradual dike slopes would enhance shoreline access and provide expanded intertidal zones, in contrast with the steeper shore protection that would be provided at other points of the island.

The park, situated as it is in a marine environment, would provide for uses related to that environment. The flatter central portion of the island could be used as a picnic area by visitors whereas other terrestrial and aquatic habitats would provide an educational resource for those interested in wildlife and aquatic organisms. At the southern end of the island a salt marsh having an area of approximately 2 acres would be created while the higher northern end of the island would contain natural landscape and seascape features. Such habitats would provide resources for wildlife, and footpaths through these areas would result in an environmental education resource.

Spectacle Island, being the closest of the Harbor Islands in the State Park to downtown Boston, would serve as a stepping stone to the more distant islands. City and State agencies would work together to provide ferry services to facilitate access to this natural park in a marine environment. Visitors could elect to explore the resources for an extended period or continue by ferry to other Park Islands which provide different amenities.

Topography, Geology, And Soils. In general, the topography resulting from the construction activities would reflect the topography of existing Spectacle Island. Impacts would include adding approximately 50 feet to the elevation of the island's northern drumlin.

The impacts to the geology and soils at Spectacle Island would, on balance, substantially improve the site. Use of the island for materials disposal would lay additional strata, including capping, on the existing, abandoned, and leaching landfill.

Hydrographics. A preliminary study has been done to evaluate the impact of the modifications to the size and shape of Spectacle Island on the hydrographic characteristics and water quality of Boston Harbor, including tidal ranges, circulation patterns, and contaminant transport (Reference "Hydrodynamic Circulation and Contaminant Transport Study for Alternative Spectacle Island Configurations" by Bechtel Civil Inc., March 1989).

A calibrated model which simulates tidal behavior, circulations, and contaminant transport in the Harbor and Massachusetts Bay, including discharges from Deer Island and Nut Island outfalls, has been used. The model was run for average tide conditions for 50 tidal cycles resulting in quasi-steady-state conditions. Tidal elevations, currents, and contaminant concentrations were compared for the existing Spectacle Island and the island configuration resulting from the use as a disposal site. Although the model used was for a slightly larger disposal option, there would be negligible changes in impacts. The results of the study are summarized as follows:

- o The impact of tide levels in the Harbor would be negligible, with changes in the tide range of less than 0.01 feet (0.3 cm). This result is reasonable since the change in tidal prism is less than 2 percent. The flow into any area of the Harbor would not be impeded.
- o The impact on currents in Boston Harbor would be negligible, except in the channel between Spectacle Island and Long Island. Even in the channel, the magnitude and direction of velocity vectors would be similar. Comparison of numerical values at selected locations indicates small differences, with changes in speed of less than 0.06 knots and in direction of less than 10 degrees, compared to the existing

condition. Differences at other locations would be smaller than in the Spectacle Island/Long Island channel. It appears that no measurable change in either the magnitude or direction of the currents adjacent to Long Island would be expected.

The construction of a confined site at Spectacle Island would not significantly impact the hydrographic parameters in Boston Harbor.

Water Quality: Water quality impacts at Spectacle Island include those during construction and those over the long-term.

Dredging of a key trench prior to construction of the rock dike around the island could result in the release of sediment-contained contaminants. Clamshell dredges and silt curtains would be used during this operation in order to minimize these water quality impacts.

As dredging proceeded, placement of the dike materials would take place under controlled conditions. Impacts from increased suspended solids and turbidity would result from the construction of the rock containment dike as well as from the filling behind the dike. In order to provide a stable foundation for the dike, it would be necessary to dredge 0.75 million cubic yards of harbor mud, silt, and clay. Turbidity and solids generated from the process would disperse to adjacent parts of the Harbor.

A modeling study was performed to assess the impact on Harbor water quality of dredging activities associated with construction of this riprap dike ("Modeling Studies of the Impact of Spectacle Island Construction on Water Quality of Boston Harbor, by Bechtel/Parsons Brinkerhoff, April 1990). It was determined that the extent and concentration of the turbidity plumes generated by the dredging activities would depend primarily on the choice of dredge. A suction dredge operated in a manner to minimize resuspension would result in a relatively small plume, with the 5 mg/l isopleth extending less than 100 m from the source. The edge of the detectable plume (by instruments), assumed to be 1 mg/l, would extend 1 to 1.5 km from the source and cover less than 1 km^2. In contrast, a bucket dredge could result in a 5 mg/l isopleth extending 1.5 km, while the 1 mg/l isopleth would extend over 3 km. However, even for the bucket dredge, the 50 mg/l isopleth, defined by DEP as the extent of a turbidity plume for previous projects, would extend less than 100 m near Spectacle Island.

The dike would be constructed in such a manner that turbid water would be contained with minimal loss. The interior of the dike would act as a sand filter removing all but the smallest size fraction of suspended particulates. Filling would take place within cells. However, allowance for overflow would have to be provided, allowing the escape of turbid water. The level of the turbidity would be controlled by the use of silt curtains.

After the filling has progressed to above the high tide level and the material consolidates, suspended particulates would no longer be a problem because tidal water would not be able to enter the area.

In general, runoff from the base camp and island construction would be discharged to the Harbor only after it has passed through a detention basin(s) for removal of suspended and floating materials. Wastewater from the contractor's facilities and operations would be collected and taken to an approved mainland location for disposal into an appropriate wastewater treatment facility or system.

The final design for the island would include a closure plan for the landfill, which would be prepared and submitted to DEP for approval. Such a plan would contain any necessary leachate collection and treatment systems to prevent the present leachate from entering the Harbor, and also facilities to properly cap material and to control drainage and runoff.

An extensive series of modeling studies were performed to assess the impact on Harbor water quality of capping the landfill on Spectacle Island (Bechtel/Parsons Brinckerhoff, April 1990). The results are as follows:

- o Leachate volume from the existing landfill has been estimated at 22 million gallons per year.
- o Capping would reduce leachate production by one to three orders of magnitude, depending on the capping design. An 8-foot clay cap with proper drainage layers above and underneath, would reduce leachate production from the existing landfill to about 1.6 million gallons per year. Use of a geomembrane under the clay cap could reduce the leachate by a factor of 10 to 100.
- o Capping of the Spectacle Island landfill under the proposed scheme would reduce concentrations of contaminants discharged in the Harbor with leachate from the old landfill by a factor of 50 or more. The use of a slurry wall in addition to the clay cap could further reduce concentrations by a factor of 2. The use of a geomembrane could reduce concentrations by a further factor of 10, at least.
- o Even if the leachate from the new fill material were similar in quality to that of the existing landfill, the concentration in the Harbor resulting from the new island would be at least a factor of 10 lower than that emanating from the existing landfill. Use of a slurry wall, or a geomembrane, could reduce the concentration by a further factor of 10.

A characterization of the existing leachate is presented in Section 4.8.4(i) (Water Quality).

Marine Sediment Quality: There would be no off-site impacts to sediment quality apart from localized incidental spills of sediment during unloading operations. This could result in a small amount of accelerated sedimentation around the unloading terminal. Periodic inspections would be made to determine the extent of accumulation and the potential need for removal.

Chemical impacts would not be detectable for two reasons. First, should contaminated excavate be placed in the containment area up to the high water level, the geochemical processes that take place in the marine environment would keep metals from leaching. The sediments placed in the intertidal area would be immobilized by high negative redox and the sulfide and chloride complexes that are prevalent in the marine environment. The second reason that chemical impacts would not be detectable is attributable to the following findings.

- With the exception of one location in the South Bay area, the contaminants have minimal leaching capability, as determined using the Extraction Procedure Toxicity test.
- Dispersion modeling (Bechtel/Parsons Brinckerhoff, March 1990) indicates that capping would reduce the generation of leachate by one to three orders of magnitude.
- The concentrations of existing leachate would be reduced by a factor of 50.

Therefore, there would be little to no short-term impacts to the chemical composition of Harbor water and no long-term impacts.

Marine Habitats And Wildlife. There are several habitat types that would be impacted by disposal at Spectacle Island. These include land under the ocean, coastal beaches, coastal banks, rocky intertidal shores, and coastal wetlands.

Spectacle Island contains six wetland resource areas subject to WPA jurisdiction. Also present are lands subject to coastal storm flowage (the 100-year floodplain) and a 100-foot buffer zone that extends from coastal banks and salt marshes. (Table 4.12 summarizes the anticipated impact to resource areas and acreage of resource areas affected.)

Land Under The Ocean: A total of about 70.9 acres of subtidal area would be impacted by dike construction and disposal of dredged and excavated material within the dike.

Hydrodynamic studies indicate that storm damage or erosion of any coastal resource areas would not be increased by filling of this land under the ocean. There would likewise be no adverse impacts on water circulation.

No eelgrass or widgeon grass beds, or shallow submerged areas with high densities of polychaetes, mollusks, or macrophytic algae would be disturbed. While some shellfish beds would be lost, construction of the rock dike would supply new habitat for shellfish.

Short-term water quality impacts may occur during construction. Capping the landfill that is currently leaching into the Harbor would provide long-term improvements to water quality.

Coastal Beaches: A total of 13.7 acres of coastal beaches would be displaced while 6.7 acres of coastal beaches would be created, resulting in a net loss of 7 acres of coastal beach. Project implementation would not result in an increase in flooding or storm damage to coastal areas nor would it cause adverse impacts to sediment transport. Although total acreage of beach habitat would be reduced by dike construction, that remaining would not be subject to existing problems of refuse contamination from the landfill.

Coastal Banks: A total of approximately 7,400 linear feet of coastal bank would be displaced by the project. However, after construction, a total of 12,000 linear feet of bank, a net increase of 2,600 linear feet, would be present on Spectacle Island. This would increase the amount of edge and shoreline habitat, an important wildlife resource.

The existing banks consist primarily of the exposed face of the landfill material and eroded banks of the north-facing shoreline. The final result of the project would be the construction of more stable banks, thus providing more stable habitat areas.

Table 4.12

POTENTIAL AQUATIC IMPACTS FOR PROPOSED SPECTACLE ISLAND

	Existing Conditions	Future Conditions		
	Original	Original Remaining	Newly Created	Total
Length of Coastal Bank (ft)	9,400	2,000	10,000	12,000
Coastal Wetlands (ac)	0.2	0	2.0	2.0
Coastal Beach (ac)	19.5	5.8	6.7	12.5
Rocky Intertidal Shoreline (ac)	18.4	0	5.2	5.2
Interstitial Surface (ac)[1]	--	--	22.5	22.5
Rocky Subtidal Shoreline (ac)	--	--	8.1	8.1
Interstitial Surface (ac)[1]	--	--	35.1	35.1
Land Containing Shellfish (ac)	14.8	1.3	-- [2]	-- [2]
Subtidal Area (ac)	N/A	N/A	N/A	-70.9

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1. Surface acreage of interstitial space between rocks is estimated
2. Rocky habitats will be available for shellfish colonization
3. N/A: Not applicable

Source: Bechtel/Parsons Brinckerhoff

Rocky Intertidal Shores: A total of 18.4 acres of rocky intertidal habitat would be permanently filled. Approximately 5.2 acres of rocky intertidal shore, in the form of a manmade dike, would be created. The proposed rock dike would be designed to withstand anticipated storm surges and wave action. The water circulation and water quality of the immediate vicinity would not be adversely impacted. Water quality would be improved by capping the landfill. The construction of the proposed rock dike with appropriate grading of substrates would replace some of the impacted wildlife and fisheries habitats. The dike structure should actually improve the quality of rocky intertidal habitat over existing conditions. The interstitial spaces (voids) between rocks within the dike would provide stable habitat for organisms such as worms, mollusks, and other marine forms. The amount of replacement habitat has been estimated at approximately 6 percent of the volume of the rock dike, based on other studies of void spaces (Ashley, 1986). Using that criteria, the dike would provide 22.5 acres of marine habitat within the rock structure. This would exceed existing conditions.

Establishment of additional rocky intertidal habitat could be provided on the east and west sides of the island by the spreading of rock from the MWRA Deer Island Outfall excavation or the proposed Combined Sewer Overflow excavation. The schedules for these projects would allow for such beneficial use of the waste rock. A net gain of productive intertidal area would be predicted and, although subtidal bottom would be lost, it is not considered as valuable or productive a resource as intertidal area.

Subtidal Rocky Substrate: The dike would create 8.1 acres of subtidal rocky habitat. Considering interstitial spaces within this habitat type, 35.1 acres of subtidal rocky habitat could be created by the dike. This would provide additional habitat, in particular, for lobsters. It also would be colonized by other benthic invertebrates, fish, and marine algae.

Coastal Wetlands: Project implementation will require the filling of approximately 8,000 square feet of salt marsh. However, as part of habitat development on the island, at least 2 acres of salt marsh would be created on the southern end of the island. This would result in a 1000 percent increase in this habitat type and a resource for environmental education and wildlife.

Land Containing Shellfish: Approximately 13.5 acres of land containing shellfish would be impacted. This would include loss of marginal habitat for soft-shelled clams. This loss would not represent any impact of commercial value because the clams are sparse and not of commercial quantity. The construction of the proposed rock dike would, in fact, create additional habitat for mollusks and lobsters. Capping of the landfill and control of leachate would protect shellfish beds in the vicinity of Spectacle Island from potential contamination. Approximately 16 acres of potential shellfish habitat would be created that would be colonized over time.

Lands Subject To Coastal Storm Flowage: No detrimental impacts to lands subject to coastal storm flowage would occur. The proposed volume of fill would not be significant in terms of the entire Harbor. Furthermore, dike construction and landfill capping activities would result in new coastal resources that would be structurally sound and able to withstand coastal storms.

Terrestrial Habitats And Wildlife. There will be a substantial adverse impact on the vegetation and wildlife located on the island for the duration of construction. In a regional context, however, this impact would not be substantial. Most of the wildlife impacts would be on birds, some of which would be temporarily displaced during disposal activities. However, use of the island as nesting habitat by several species has already diminished greatly, possibly as a result of plant succession in recent years.

Final design for terrestrial habitats would include diverse vegetative plantings and strata (see Figure 4.43). Creation of edge habitats would be emphasized to help enhance overall diversity and abundance of wildlife species. Expanded acreage combined with appropriate contouring and vegetation would result in a greater habitat resource than currently exists. Both terrestrial vertebrates, and especially vertebrates associated with aquatic ecosystems (such as egrets), would benefit. By creating habitats conducive to maintaining nesting populations, resources would be available for bird species historically present but currently lacking.

Threatened And Endangered Species. Work at Spectacle Island would have no adverse effects on threatened or endangered species.

Floodplains. Filling will occur on the floodplain of Spectacle Island, and perimeter dikes would keep flood flows away from the existing floodplain. This loss of floodplain would have minimal regional impact. Flood volumes previously accommodated on the Spectacle Island floodplain will be diverted to floodplain areas elsewhere in the Harbor with no net effect on the 100-year storm event flood level.

Historic And Archaeological Impacts. There are no National Register eligible historic structures on Spectacle Island.

Spectacle Island is the site of Prehistoric Archaeological Site 19-SU-38, which is part of the Boston Harbor Islands National Register Archaeological District. Long-term preservation of the site could not be insured with use of the island for disposal. Mitigation would be proposed in the form of a scientifically conducted data recovery program prior to construction. This program, to be reviewed by City and State archaeologists, would include research on the site, an excavation plan, a conservation plan, and a public education program.

Visual Impacts. The expansion of Spectacle Island would change the visual relationship between land and water in this portion of the Harbor. Boaters in the Presidential Roads would view Spectacle and Long Islands as overlapping bodies rather than as two land masses separated by water. The two-drumlin topography of the island would be maintained, although the drumlins would be larger than those existing today. The stone dike around the perimeter of most of the site would change the character of the edge. Altering the slope of the dike would provide variation in edge conditions.

Land Use And Social Impacts. Use of this site would upgrade the island and give it the potential for use as a site for environmental recreation or other public use. The proposed action would allow island use for environmental education activities and wildlife observation as provided in the DEM master plan for the island. [See Section 4(f) Evaluation in Part III of the SEIS/R for parkland discussion.]

The social impacts are also expected to be beneficial because the disposal activities will remediate the existing landfill and prepare the site for future publicly beneficial use (wildlife habitat and park land).

Tidelands. The fill and structures recommended for Spectacle Island will require a Chapter 91 license from DEP, which involves a determination that the proposed use of the island serves a proper public purpose and is a water-dependent use. The determination will be based on a balancing of natural resource impacts of filling tidelands with the land use, social, and visual impacts. The Chapter 91 interests served by the project are the reclamation of despoiled tidelands which are a public safety hazard, the creation of active and passive waterfront recreation opportunities and improved environmental education for visitors to the Boston Harbor Islands. There will be continuous public access at the water's edge around the island, and recreational fishing will be possible from the dikes, thereby activating the edge of the property as required by DEP.

Economic Impacts. Spectacle Island presently has no population and is not the site of any economic activity. However, the recommended materials disposal at this site would subsequently have positive economic impacts.

Relocation Impacts. No current activities would be displaced or impacted by use of this site either on Spectacle Island (where there is no activity) or on the neighboring islands. In addition, there would be no impacts on airport activities at Logan Airport.

Traffic/Transportation Impacts. There would be no traffic impacts associated with the use of Spectacle Island. Redevelopment of Spectacle Island following its capping and restoration would permit access to the island by ferries and private boats which now cannot safely approach the island. Suitable shoreside facilities will be developed as part of the planning process for reuse of the island.

Air Quality. Construction period air quality impacts would potentially result from emissions of CO, NO, and particulates from construction vehicles, tugboats at the barge unloading facility, tugboats and cranes at the dike construction areas, and fugitive dust from construction activities. Since the excavated material would be wet, the amount of fugitive dust would be limited. Because of the distances to the nearest onshore receptors, no adverse air quality impacts would be expected from activities on the island.

Noise And Vibration. During construction of the dikes and placement of the excavated material, the noise and vibration levels on the island would increase substantially. The noise and vibration from these construction activities would not adversely impact sensitive receptors off the island because of the attenuation effect of the distances between the island and the receptors.

Mitigation. Although the proposed design for disposal at Spectacle Island provides for substantial aquatic and terrestrial habitat, additional mitigation measures would be developed.

Several design criteria would be used during later design phases to further promote diverse and abundant wildlife and aquatic resources. Some pertinent criteria, that would be considered, are:

- *Size Of Boulders:* These affect shore stability, interstitial space for accumulation of sediments, and habitat diversity.

- *Seeding Of Dike:* The addition of cobble, gravel, and sand would create additional habitat diversity, especially in areas with lower sediment deposition. Current substrate types displaced by fill could be copied and replaced in areas adjacent to the dikes.

- *Slope Of Dike:* The incline of the dike could be designed not only to dissipate wave and currents but also to provide appropriate depths and gradations for establishing substrates and biological communities. Further analysis to enhance the ecological function of the proposed dike design would occur throughout preliminary and final design.

- *Biological Seeding:* Benthic organisms (i.e.,shellfish and other invertebrates) displaced by fill might be relocated to outer dike surfaces to enhance the rate of colonization. The diversity of benthic communities would likely increase with stabilization of sediments.

- *Slope Of Upland Fill:* Contouring could influence colonization of shorelines by wetland vegetation and also could enhance use by shorebirds.

- *Upland Contouring:* This could be used to create moist upland areas such as grass dominated wet meadows. Such habitat would be a valuable resource for birds and small mammals.

- *Vegetation:* Selective planting would provide food resources, refuge, and roosting and nesting areas for wildlife. This would promote island use by small mammals and nesting and migrating bird species.

These criteria would be developed further in conjunction with DEM, EPA, and other resource agencies.

Ecological Overview. Expanding and capping Spectacle Island would provide a benefit to the ecological resources and natural heritage of Boston Harbor.. The distinct history of physical and natural disturbance at Spectacle Island has limited its ecological diversity and created unstable upland and tidal environments. Expansion of the island combined with appropriate design and landscaping would improve environmental conditions and enhance wildlife resources in Boston Harbor. Thus, use of Spectacle Island for materials disposal presents an unusual opportunity to create additional wildlife and wetlands habitat in a metropolitan area.

Terrestrial environments at Spectacle Island have low diversity, and much of the island is dominated by staghorn sumac. Existing conditions and the lack of historic vegetation patterns have resulted from previous land uses and landfill fires. Newly created environments could include vegetation plantings and topography supportive of small mammals and birds. Through vegetation management and expanded acreage, the island would serve as a more effective resource for migrating, wintering, and nesting bird species than is now possible.

The existing aquatic environment at Spectacle Island includes an eroding landfill that continues to foul Boston Harbor and diminish the island as an ecological resource. Through expansion of the island, landfill erosion would be stopped, a more stable environment established, water quality improved, and additional edge habitat created. All of these factors represent an opportunity for positive change over existing conditions and expanded habitat for shoreline species. Appropriate placement of dikes and distribution of boulders and cobble substrates abutting dikes would provide stability and promote colonization by aquatic organisms. Such actions could thus result in a greater and more stable resource than currently exists.

Use of Spectacle Island for materials disposal would provide an opportunity to heal an environmental wound and reverse the loss of shoreline habitat that has continued since the founding of Boston. Use of Spectacle Island would create an increase in habitat diversity and value, eliminate the erosion and leachate from the garbage dump, and allow the island to become the rightful centerpiece of the Harbor Islands Park.

Creating the most ideal ecological resource and programming its use would require goodwill and dedication among many organizations and agencies. Consultations during the design of Spectacle Island would be made with senior representatives of DEM and the City of Boston (as owners and managers), EPA, Corps of Engineers, DEP, Friends of Harbor Islands, DPW, Massachusetts Audubon, The Boston Harbor Association (TBHA), CLF, and other major environmental groups. The spirit of Olmsted and his legacy of design should guide the final landscaping to approach his vision.

Summary:

- Use of Spectacle Island for disposal would impact intertidal, subtidal, and terrestrial resources with subsequent replacement and improvement of major portions of these resources.
- There would be little or no impacts to communities from disposal operations.
- There would be substantial and positive benefits to the ecological resources of Spectacle Island and Boston Harbor.
- This site is recommended for materials disposal because expanding and capping Spectacle Island would result in the net creation of wildlife habitat and substrate for aquatic organisms, and would improve water quality by diminishing the leachate from the existing landfill. Use of this site is technologically and economically feasible, promotes overall project objectives, and has a net beneficial environmental impact.

4.9 COMPARISON OF ENVIRONMENTAL IMPACTS OF ALTERNATIVE DISPOSAL APPROACHES

4.9.1 Introduction

The previous section (4.8) has assessed in detail the impacts associated with nine alternative individual disposal sites (Table 4.13). An integrated materials disposal plan

Table 4.13

SUMMARY OF INITIAL IMPACTS ON COMBINED AQUATIC RESOURCE AREAS

	Disposal Site									
Function	**Bedford**	**East Brookfield**	**Malden**	**Weymouth**	**MBDS**	**Logan North**	**Logan West**	**Hull**	**Governors Island**	**Spectacle Island**
Groundwater Recharge	L	L	N	L	N	N	N	N	N	N
Groundwater Discharge	M	M	N	M	N	N	N	N	N	N
Groundwater Supply	M	L	N	N	N	N	N	N	N	N
Flood Storage	M	L	N	L	N	N	N	N	N	N
Sediment/Shore Stabilization	N	N	N	N	N	L	L	N	L	$N^{(+)}$
Sediment/Toxicant Retention	M	L	N	L	N	M	L	M	M	M
Nutrient Retention/ Transformation	M	L	N	L	M	M	L	M	M	M
Surface Water Supply	L	N	N	N	N	N	N	N	N	N
Nutrient Export	M	L	N	L	N	L	L	N	L	$N^{(+)}$
Aquatic Diversity	L	L	N	L	L	L	L	M	M	$M^{(+)}$
Fish Habitat	M	L	N	L	L	M	L	M	M	$M^{(+)}$
Shellfish Habitat	N	N	N	N	L	M	M	N	M	L
Wildlife Habitat	H	M	$N^{(+)}$	M	L	L	L	L	M	$M^{(+)}$
Endangered Species	N	L	N	N	N	N	N	N	N	N
Recreation	L	L	N	N	L	M	L	L	L	$L^{(+)}$
Uniqueness/Heritage	L	L	N	N	N	N	N	N	N	$L^{(+)}$

N = No impact
L = Low impact
M = Moderate impact
H = High impact
+ = Project actions should produce a net beneficial impact

Source: Bechtel/Parsons Brinckerhoff

for the Artery/Tunnel Project's excavated fill, mixed clay/fill, and unacceptable dredged material, could theoretically use one, several, or all of these sites in combination.

This section 4.9 describes comparative environmental impact evaluations which have been undertaken regarding alternatives using different combinations of the nine sites. This analysis has been undertaken in this SEIS/R in order to provide a fuller understanding of the overall environmental implications of different integrated disposal programs, particularly the incremental impact differences of using Spectacle Island for different amounts of material. In order to perform this comparison, four inland sites identified as potentially usable in the preliminary screening process, and assessed in the previous Section 4.8, are included in the alternative materials disposal approaches evaluated. While these four inland sites are the best potential sites that have emerged in Project studies for the SEIS/R, it appears from the assessment conducted to date that these four inland sites may not in fact be available or workable disposal options that adequately satisfy project objectives. Further studies of these and other inland sites will be undertaken during public review of the DSEIS to refine the alternatives comparison, if possible. However, the analysis using the currently-known best potential inland sites is presented in this document to promote comprehensive disclosure of, and broad public and agency review of, potential environmental impacts of inland, marine, and combination alternatives.

In this Section 4.9, two kinds of comparative evaluations are presented. First the environmental impacts of use of the five non-ocean marine sites -- Governors Island Flats, Hull Bay, Logan Airport North, Logan Airport West, and Spectacle Island -- are compared in order to identify the environmentally preferable option(s) among those sites.

Second, a series of alternative materials disposal approaches using different combinations of inland and marine sites are evaluated in order to compare their environmental impacts.

The combined approaches assessed below for this purpose include: assignment of all projected excavated fill, mixed clay/fill, and unacceptable dredged materials to Spectacle Island (a marine site); assignment of all of these materials to inland sites; and combinations of inland and marine sites for these materials. Such combinations include use of multiple inland sites with the balance of material going to Spectacle, two inland sites with the balance of material going to Spectacle, and one inland site with the balance going to Spectacle.

In all of the integrated disposal approaches compared below, acceptable dredged material is assumed to be barged to the Massachusetts Bay Disposal Site (MBDS), and most of the unmixed clay and till is assumed to be made available for capping existing landfills, for reasons discussed in Sections 4.5 and 4.6 of this chapter. (Each of the disposal approaches would use a different amount of capping material for project disposal sites, leaving varying amounts available for sanitary landfill closures.) In all disposal approaches the project would maximize use of material with suitable physical characteristics to meet specifications for construction backfill. In all disposal approaches, relatively small quantities of materials would also need to be disposed by contractors relocating utilities; these contractors would secure individual permits to deposit the material in approved landfills.

4.9.2 Comparison Of Marine Sites

Of the marine sites, Governors Island Flats could potentially provide a location for disposal of all project fill, unacceptable dredged material, and other excavated material. However, this 418-acre site is a productive area and is used for commercial shellfish harvesting. The 24-acre saltmarsh in the area of Governor Island Flats is an important wildlife habitat. Mudflats and tidal creeks provide feeding grounds for various birds.

Use of this site would involve filling 238 acres of open water and intertidal flats, including the loss of 34 acres of economically viable shellfish beds and the reduction of shoreline and coastal bank habitat. The loss of these natural resources and the ecological value associated with them is important in view of their contribution to the Harbor environment at present and in the future after the Harbor clean-up has been implemented. Therefore, substantial impacts to aquatic resources would result from use of this site for disposal of the project's material.

The remaining, subaqueous, marine sites (Logan Airport North, Logan Airport West, and Hull Bay) are much smaller in size and, because they are unconfined, they have problems similar to ocean disposal in containing silt and floatable materials. These characteristics, which make the material unsuitable for ocean disposal, are more serious at these shallow water sites because of the greater potential for siltation of nearby underwater habitats and for silt and floatables to disperse to nearby shoreline and marsh habitats.

The two sites at Logan Airport could potentially accommodate 1 million cy at the North site and 420,000 cy at the West site. Both sites are marine underwater borrow pits. Commercial shellfishing is permitted in subtidal areas but not in the intertidal zones. Placement of large quantities of materials at these sites would reduce the capacity of the waters to assimilate the pollutant loads from the combined sewer overflows and other discharges to those waters from both point and nonpoint sources. In addition, Constitution Beach is a public recreation area and other adjacent recreational boating areas would be curtailed during the period of disposal by siltation of the beach and washing up of floatable debris. Thus, on the basis of both aquatic and recreational/open space impacts, it has been concluded that these two sites are inferior to Spectacle Island for material disposal.

The Hull Bay disposal area, with a capacity of about 800,000 cy, has previously been used for dumping but is now inactive. Because it is unconfined, tidal currents in this area could disperse the fine silt and clay particles, possibly transporting them to an area of shallows northwest of Bumpkin Island with impacts on shoreline and shallow water habitats. Additionally, the main navigation channel is about 400 yards to the west of the site and would limit the height and volume of fill to a small fraction of project requirements.

In conclusion, a disposal approach employing a confined marine disposal site at Spectacle Island would be substantially superior in terms of aquatic and other environmental impacts as compared to use of the other marine sites singly or in combination.

4.9.3 Description Of Alternative Disposal Approaches

A series of landfill combinations, ranging from all inland sites to Spectacle Island alone, have been considered for disposal of excavated fill, clay, till and unacceptable dredged material. These disposal approaches are described below.

4.9.3(a) Predominantly Inland Disposal Approach

This approach is dominated by the use of inland disposal sites. The following materials could be disposed among the sites included in this approach:

By Truck: 379,000 cy to landfills (by utilities relocation contractors)
1,182,000 cy to cap sanitary landfills
10,566,000 cy to inland landfills (Malden, Weymouth, East Brookfield, and other inland sites)
By Barge: 1,406,000 cy to Massachusetts Bay Disposal Site (MBDS)

Total 13,533,000 cy

These totals can be broken into material types as follows:

MBDS: 1,205,000 cy acceptable dredged material
201,000 cy dredged rock

Landfills: 379,000 cy excavation for utilities relocation
2,284,000 cy of clay and till to cap landfills created by the project
1,182,000 cy of clay and till to cap sanitary landfills
1,010,000 cy of unacceptable dredged material
7,272,000 cy of fill, clay and till and other excavated material

The inland approach contains the following major elements:

- The native clay and till would be used primarily to line and cap the new landfills created for project materials. This function would utilize approximately 70 percent of the total quantity of native clay and till excavated by the project. The remaining material would be advantageously used to cap existing landfills, especially those which drain to a marine environment.

- Fill, clay, till and other excavated material would be disposed at the inland sites.

- The unacceptable dredged material would be disposed at the inland sites. The dewatering of this material would not be possible at the project site as a result of space constraints (see Sections 4.2 and 4.7). The material would be hauled in sealed trucks and dewatered at the inland sites prior to spreading.

- The acceptable dredged material would be disposed at the designated Massachusetts Bay ocean disposal site (MBDS). It would be placed directly onto barges.

4.9.3(b) Combined Approach Utilizing Multiple Inland Sites And Capping Of Spectacle Island

An approach could be defined which uses inland sites for excavated fill and mixed clay/till and includes stabilization and capping of Spectacle Island with dredged rock, fill, unacceptable dredged material and capping material. Materials could be disposed at the following sites under this option:

By Truck:	379,000 cy to landfills (by utilities relocation contractors)
	1,466,000 cy to cap sanitary landfills
	8,250,000 cy to inland landfills (Malden, Weymouth, East Brookfield)
By Barge:	2,233,000 cy to Spectacle Island
	1,205,000 cy to MBDS
Total	**13,533,000 cy**

These totals can be broken into material types as follows:

MBDS:	1,205,000 cy acceptable dredged material
Landfills:	379,000 cy excavation for utilities relocation
	1,466,000 cy native clay and till for capping sanitary landfills
	1,800,000 cy native clay and till for capping project landfills
	6,450,000 cy fill, clay, till and other excavation material
Spectacle Island:	1,010,000 cy unacceptable dredged material
	200,000 cy native clay and till for capping
	822,000 cy fill, clay, till and other excavated material
	201,000 cy dredged rock
Total	**13,533,000 cy**

This combined approach contains the following major elements:

- Using material from the Artery/Tunnel Project, Spectacle Island would be used for unacceptable dredged material and stabilized with dredged rock; the abandoned landfill would be closed and capped with native clay and till.
- Acceptable dredged material would be disposed at the MBDS.
- Excavated fill, mixed clay/till would be disposed at the four inland sites developed through the screening process.
- The remaining clay/till would be used to line and cap the new inland site landfills, leaving approximately 1,466,000 cy of this material available for capping existing sanitary landfills.
- This approach would provide capping of the existing Spectacle Island landfill and stabilization of the island, necessary to implement the Boston Harbor Islands State Park Master Plan (1986). [See Section 4(f) Evaluation in Part III of the SEIS/R.]

4.9.3(c) Combined Approach Utilizing Two Inland Sites And Spectacle Island

In this approach, the fill would go to two inland sites: Rowe Quarry in Malden and Weymouth. The remainder would go to Spectacle Island.

The following materials would be disposed at the sites which form this combined approach:

By Truck:	379,000 cy to landfills (by utilities relocation contractors)
	1,616,000 cy to cap sanitary landfills
	5,500,000 cy to inland landfills (Malden and Weymouth)
By Barge:	4,833,000 cy to Spectacle Island
	1,205,000 cy to MBDS
Total	**13,533,000 cy**

These totals can be broken into material types as follows:

MBDS:	1,205,000 cy acceptable dredged material
Landfills:	379,000 cy excavation for utilities relocation
	1,616,000 cy native clay and till for capping sanitary landfills
	1,150,000 cy native clay and till for capping project landfills
	4,350,000 cy fill, clay, till and other excavation material
Spectacle Island:	1,010,000 cy unacceptable dredged material
	700,000 cy native clay and till for capping
	2,922,000 cy fill, clay, till and other excavated material
	201,000 cy dredged rock
Total	**13,533,000 cy**

This combined approach contains the following major elements:

- o The native clay and till would be used to cap Spectacle Island and to line and cap the project landfills at the two inland sites. The remainder would be used to cap existing landfills, especially those which drain to a marine environment.
- o Fill, clay, till and other excavated material would be disposed at two inland sites and Spectacle Island.
- o The unacceptable dredged material would be disposed at Spectacle Island.
- o The acceptable dredged material would be disposed at the designated ocean disposal site. It would be placed directly onto barges.
- o This approach would provide capping of the existing Spectacle Island landfill and stabilization of the island, necessary to implement the Boston Harbor Islands State Park Master Plan (1986).

4.9.3(d) Combined Approach Utilizing One Inland Site And Spectacle Island

In this approach, some fill would go to an inland site (Rowe Quarry in Malden), and the remainder would go to Spectacle Island.

The following materials would be disposed at the sites which form this combined approach:

By Truck:	379,000 cy to landfills (by utilities relocation contractors)
	2,750,000 cy to Malden
	2,216,000 cy to cap sanitary landfills
By Barge:	6,983,000 cy to Spectacle Island
	1,205,000 cy to MBDS
Total	**13,533,000 cy**

These totals can be broken into material types as follows:

MBDS:	1,205,000 cy acceptable dredged material
Landfills:	379,000 cy excavation for utilities relocation
	500,000 cy native clay and till for capping project landfills
	2,216,000 cy native clay and till for capping sanitary landfills
	2,250,000 cy fill, clay, till and other excavation material
Spectacle Island:	1,010,000 cy unacceptable dredged material
	750,000 cy native clay and till for capping
	5,022,000 cy fill, clay, till and other excavated material
	201,000 cy dredged rock
Total	**13,533,000 cy**

This combined approach contains the following major elements:

- The native clay and till would be used to cap Spectacle Island and to line and cap the new project landfill in Malden. The remainder would be used to cap existing landfills, especially those which drain to a marine environment.
- Fill, clay, till and other excavated material would be disposed at Spectacle Island and one inland site.
- The unacceptable dredged material would be disposed at Spectacle Island.
- The acceptable dredged material would be disposed at the designated ocean disposal site. It would be placed directly onto barges.
- This approach would provide capping of the existing Spectacle Island landfill and stabilization of the island, necessary to implement the Boston Harbor Islands State Park Master Plan (1986).

4.9.3(e) Disposal Approach Utilizing Spectacle Island

In this approach Spectacle Island would be used for excavated fill, mixed clay/till, and unacceptable dredged material.

The Spectacle Island disposal approach would utilize a combination of sites and transportation modes, with barge transport predominating, as follows:

By Truck:	379,000 cy to landfills
	2,666,000 cy to cap sanitary landfills
By Barge:	9,283,000 cy to Spectacle Island
	1,205,000 cy to MBDS
Total:	**13,533,000 cy**

These totals can be broken into material types as follows:

MBDS:	1,205,000 cy of acceptable dredged material
Landfills:	2,666,000 cy of clay and till for capping
	379,000 cy to landfills
Spectacle Island:	1,010,000 cy of unacceptable dredged material
	800,000 cy of clay and till for capping
	7,272,000 cy of fill, clay, till and other excavated material
	201,000 cy of dredged rock
Total:	**13,533,000 cy**

This disposal approach contains the following elements:

- Essentially all of the native clay and till would be used to cap existing landfills, especially those which drain to a marine environment.

- The fill, unacceptable dredge, and other excavated materials would be disposed at the contained marine site at Spectacle Island. This approach would provide capping of the existing landfill and stabilization of the island, necessary to implement the Boston Harbor Islands State Park Master Plan (1986).

- The acceptable dredged material would be disposed at the designated ocean disposal site. It would be placed directly onto barges.

4.9.4 Key Impact Issues For Comparing Disposal Approaches

This section reviews by impact area the key issues associated with the five alternative disposal approaches. The following section (4.9.5) discusses and compares more specifically the environmental impacts of each alternative approach considered.

Primary among the environmental impact areas differentiating the alternative disposal approaches are the nature of aquatic impacts. These may include filling or alteration of ocean waters and marine habitats, filling or alteration of freshwater wetlands and associated wildlife habitats, and indirect impacts on adjacent water or wetlands regions.

Other environmental impact areas which have been assessed, as discussed below, are: water supply impacts; wildlife impacts; public open space uses; waste siting and management considerations; and regional and local construction and operational impacts of the disposal process.

4.9.4(a) Aquatic Impacts

Aquatic impacts of the different combination approaches involve very different ecological systems. These approaches could fill waters of the United States and/or involve a variety of wetlands and other environmental resources as described in Section 4.8.4 and summarized in Tables 4.13 and 4.14. The inland sites have wetlands that would be affected, while the impacts at Spectacle Island would include direct intertidal and subtidal changes and losses, as well as benefits from containment of the uncapped garbage dump.

The predominantly inland approach impacts on wetlands at four different sites. These include direct filling at Bedford, East Brookfield, and Weymouth, and potential impacts through the fissured bedrock coastal wetlands from the Malden site. This approach does not effect Spectacle Island's resources, but does nothing to stop the leaching and erosion of the refuse there.

The combined approach of multiple sites and capping of Spectacle Island would somewhat reduce the impacts on wetland areas inland but would have impacts on several habitat types at Spectacle Island as summarized in Tables 4.15 and 4.16. However, the leaching and erosion of the existing garbage at Spectacle Island would be controlled, providing an important benefit for habitat quality around Spectacle Island.

The combined approach with two inland sites reduces wetland impacts by eliminating the East Brookfield impacts. The additional Spectacle Island impacts would mainly be the loss of land under the ocean and shellfish habitat.

However, the rocky subtidal shoreline would be increased quantitatively, and the interstitial spaces in the dikes actually would provide additional surface for colonization. The coastal bank also would be substantially increased.

The next combination approach, with one inland site, removes the direct inland wetland impacts and leaves only the potential damage to coastal wetlands. The additional impact at Spectacle Island would then be only on land under the ocean (loss of 12 more acres), with gains in coastal bank and subtidal shoreline.

The predominantly Spectacle Island approach would remove the last inland wetland impact (from the Malden site), but would also increase the loss of land under the ocean by 12 acres. However, the coastal bank at Spectacle Island would become longer by 875 feet and no other changes would occur there.

In summary, all alternatives result in a loss of aquatic resources, yet they differ in the types of resources impacted. All inland sites are generally "low" areas which have capacity for retaining materials. A primarily inland disposal approach would fill low areas which

Table 4.14

AQUATIC RESOURCE AREA IMPACTS IN POTENTIAL DISPOSAL SITES

Disposal Site	Footprint (acres)	Tidal Waters (acres)	Rocky Intertidal (acres)	Coastal Mudflat (acres)	Coastal Wetland (acres)	Non-Tidal Water (linear ft)	Natural Pond (acres)	Inland Wetland (acres)
Bedford	58	0	0	0	0	5,250	0	58.0
East Brookfield	91	0	0	0	0	0	0	20.2
Malden	60	0	0	0	0	0	0	4.0
Weymouth	81	0	0	0	0	0	5.4	12.2
MA Bay Disposal Site	2,000	N/A	0	0	0	0	0	0
Logan North	114	114 *	0	0	0	0	0	0
Logan West	34	34 *	0	0	0	0	0	0
Hull	500	500 *	0	0	0	0	0	0
Governors Island	287	247	0	40	0	0	0	0
Spectacle Island**	186	84.6	18.4	0	0.2	0	0	0

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1. N/A = Not applicable
2. * Represents replacement of old with new bottom
3. ** Assumes disposal site capacity of 9.3 mcy

Source: Bechtel/Parsons Brinckerhoff

Table 4.15

COMPARISON OF RESULTING CONDITIONS ASSOCIATED WITH VARIOUS SPECTACLE ISLAND APPROACHES

Habitat Type	Existing Island	Capping Only	Intermediate Island	Intermediate Island	Proposed Island
Area within toe of dike (ac)	83 (3)	106	163	175	186
Area of Terrestrial Habitat (ac)[2]	83	106	142	154	165
Coastal Bank (linear ft)	9,400	9,600	10,780	11,130	12,000
Coastal Wetlands (ac)	0.2	2.0	2.0	2.0	2.0
Coastal Beach (ac)[2]	19.5	11.6	12.5	12.5	12.5
Rocky Intertidal Shoreline (ac)	18.4	12.2	4.5	4.7	5.2
Interstitial Surface (ac)[1]	--	3.9	19.4	20.1	22.5
Total		16.1	23.9	24.8	27.7
Rocky Subtidal Shoreline (ac)	0.0	0.4	2.9	7.2	8.1
Interstitial Surface (ac)[1]	--	1.6	12.4	31.3	35.1
Total		2.0	15.3	38.5	43.2
Land Containing Shellfish (ac)	14.8	4.4	1.3	1.3	1.3

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1. Surface acreage of interstitial space between rocks is estimated
2. Defined by mean high tide
3. Area of Island at mean high tide

Source: Bechtel/Parsons Brinckerhoff

Table 4.16

COMPARISON OF NET IMPACTS ASSOCIATED WITH VARIOUS SPECTACLE ISLAND APPROACHES

Habitat Type	Existing Conditions	Capping Only	Intermediate Island	Intermediate Island	Proposed Island
Area of Terrestrial Habitat (ac)	83	+23	+59	+71	+82
Coastal Bank (linear ft)	9,400	+200	+1,380	+1,725	+2,600
Coastal Wetlands (ac)	0.2	+1.8	+1.8	+1.8	+1.8
Coastal Beach (ac)[2]	19.5	-7.9	-6.7	-6.7	-6.7
Rocky Intertidal Shoreline (ac)[1]	18.4	-17.5	-13.9	-13.7	-13.2
Total		-13.6	+5.5	+6.4	+9.3
Rocky Subtidal Shoreline (ac)[1]	0.0	+0.4	+2.9	+7.2	+8.1
Total		+2.0	+15.3	+38.5	+43.2
Land Containing Shellfish (ac)	14.8	-10.4	-13.5	-13.5	-13.5

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1. Estimate of net change in habitat when interstitial space between rocks is included
2. Defined to mean high tide

Source: Bechtel/Parsons Brinckerhoff

are typically vegetated by wetland species. An alternative disposal approach, using primarily Spectacle Island, would replace rocky intertidal shore and some coastal wetlands. A major difference between approaches is obvious, in that modification of the Island's shore results in a replacement of aquatic resources whereas filling inland areas constitutes a loss.

All inland sites have either natural, transitional wetland associations or man-made wetland conditions resulting from colonization of disturbed areas. Development of these areas has been curtailed in recent years by state and federal regulations because they are recognized as valued and limited inland aquatic resources. Changes to aquatic resources in primarily inland disposal scenarios include those associated with site development and consequential impacts to adjacent surface waters.

The increased utilization of Spectacle Island for disposal would primarily eliminate land beneath the ocean; this loss, like inland low areas, is irretrievable. Intertidal rocky areas, however, would increase with incremental increases in material used as cap or fill. The initial loss of shoreline resource would be replaced with a more stable aquatic resource. Shore would be increased for use by birds and other wildlife associated with aquatic ecosystems. There would be increased wetlands (developed) and intertidal and subtidal habitats would be subsequently colonized by marine organisms.

4.9.4(b) Other Long-Term Environmental Impacts

Water Supply Impacts. Protection of public drinking water supplies against contamination is one of the primary goals of both EPA and DEP. State and federal laws and regulations have been established to protect sources of drinking water (e.g., sole source aquifer protection programs), prescribe acceptable levels of drinking water quality (through the Safe Drinking Water Act), and clean up sources of contamination to water supplies (federal and state Superfund programs).

In Massachusetts and other New England states, communities rely on both surface and groundwater sources for drinking water. Saline or brackish waters are not considered to be potential water supplies because of the cost of salt removal and the relative availability of freshwater supplies. Improper disposal of municipal and industrial wastes have contaminated many community water supplies in recent years. Therefore, protection of remaining water supplies (both actual and potential) is a key concern at the federal, state, and local levels.

Disposal sites that drain to fresh surface or groundwater resources have the potential to affect present or future drinking water supplies, whereas sites that drain to a marine or estuarine environment do not. Sites evaluated for the disposal of Artery/Tunnel project dredged and excavated material include a site that drains to presently used sources of drinking water (E. Brookfield), a site that drains to a past source of drinking water that could be used again in the future (Bedford), and a site that could affect an aquifer that is not presently used as a source of drinking water (Malden). The Spectacle Island site has no potential to affect water supplies. From the standpoint of water supply impacts, the placement of all fill material at Spectacle Island is clearly preferable.

Wildlife. Use of more numerous disposal sites would potentially increase the cumulative and long-term displacement of wildlife and vegetation resources resulting from the projectwide disposal scheme. Not only does filling a wetland produce localized impacts on wildlife within a particular disposal site, but it also impacts the many vertebrate species that range considerable distances to use such habitat as a foraging or breeding/nesting resource. Therefore, as more disposal sites are used, there is greater potential for impact on regional wildlife resources.

There would be varying degrees of wildlife impacts associated with the use of each inland site (Table 4.17). Most pronounced impacts would be at East Brookfield and Bedford, while little impact would occur at Malden. No impacts to rare wildlife species would be anticipated if any of those inland sites were used.

Any use of Spectacle Island would include major loss of existing wildlife habitat and wildlife displacement during disposal operations. However, upon completion, there would be increased shoreline and terrestrial (aquatic-associated) habitat for birds and small mammals. Unlike inland approaches, where aquatic resources are eliminated by filling, the Spectacle Island approach would result in the enhancement of wildlife habitat resources for species associated with aquatic ecosystems.

Public Open Space. A key objective of Artery/Tunnel project design studies since approval of the 1985 FEIS/R has been to minimize any adverse project impacts on, and to support and enhance use of public parks, recreation areas, and open spaces. Of particular importance is facilitating public access to and use of Boston's unique waterfront areas on Boston Harbor and along the Charles River. Both the Commonwealth's and the City of Boston's policies for these areas strongly favor preserving and enhancing active pedestrian, marine, and various water-dependent uses.

The investigation of Spectacle Island as a potential project materials disposal site since the 1985 FEIS/R was in part a response to these objectives, which have been accorded increasing importance by state environmental resource agencies in recent years. Spectacle Island, although formally designated a part of the Boston Harbor Islands State Park, is in fact unusable as an actual park in its current hazardous condition as an uncapped landfill. The 1986 Boston Harbor Islands State Park Master Plan determined that Spectacle Island could be used as a park only if a large public project could provide (at no cost to the park agencies) sufficient material to cap and contain the existing landfill there. The Artery/Tunnel Project's materials disposal program provides this opportunity to create a special waterfront park environment, and to complete the most difficult link in the Boston Harbor Islands State Park system.

The potential availability of additional Harbor recreational resources to the public, for a range of water-dependent uses, and access to and enhancement of water-related natural resources, is of particular value. While open space could potentially also be provided at inland disposal sites, by capping disposal mounds there following project disposal activities, the four inland sites considered offer no special or unique open space qualities compared with additional parkland in Boston Harbor. Alternative disposal approaches which include capping and stabilizing Spectacle Island as a park provide, in contrast, a distinctive environmental benefit with respect to public open space uses.

Solid Waste Siting And Management Considerations. The Massachusetts DEP regulates the management of existing solid waste landfills and the siting and establishment of new

Table 4.17

SUMMARY OF DIRECT IMPACTS TO ENVIRONMENTAL CONDITIONS OF POTENTIAL DISPOSAL SITES

	Spectacle Island	*Bedford*	*East Brookfield*	*Weymouth*	*Malden*
Estimated Capacity (cu. yds.)	9.3 million	2.1 million	2.7 million	2.7 million	2.7 million
Footprint (acres)	186	58	91	81	60
Wetlands Lost (acres)	0.2	58	20.2	12.2	0.4
Non-Tidal Water	NA	Low pH, nutrients to Elm Brook	Suspended solids in pond, Seven Mile River	5.4 acres of open water lost	0
Tidal Water	84.6 acres	NA	NA	NA	NA
Groundwater	NA	Within Zone II	Near Zone II	Near public water supplies. Fissured rock, exposed recharge, requires liner (difficult) and leachate collection	Fissured rock, exposed recharge, requires liner (difficult) and leachate collection
Habitat Diversity	Loss of "original" intertidal and subtidal shore and 0.2 acres of wetland	Loss of transitional wetlands	High and indirect impacts to diverse habitats	Loss of disturbed wetlands	Low impact in quarry
Route Distance	Less than 1 mile	20.6 miles	66.8 miles	18.6 miles	6.0 miles
Truck Traffic Volume	*	Interstate – **Low** (12% maximum ADTT increase) Primary – **Very High** (238% increase ADTT)	Interstate – **Low** (23% maximum ADTT increase) Primary – **Very High** (104% ADTT increase)	Interstate – **Low** (9% maximum ADTT increase) Primary – **Low** (20% ADTT increase) Local – **Very High** (259% ADTT increase)	Primary – **High** (maximum 60% ADTT increase)
Roadway Condition	*	Interstate – **Moderate/High** (0.3-0.4 years reduced pavement life) Primary – **Very High** (0.6-8.7 years reduced pavement life)	Interstate – **Moderate/High** (0.4-0.9 years reduced pavement life) Primary – **High** (3.8 years reduced pavement life)	Interstate – **Moderate/High** (0.3 years reduced pavement life) Primary – **Moderate/High** (0.7 years reduced pavement life) Local – **Very High** (9.5 years reduced pavement life)	Primary – **Moderate/High** (0.7 years reduced pavement life)
Air	*	**Low** (53 tons NOx/ peak four quarters)	**Low** (150 tons NOx/ peak four quarters)	**Low** (50 tons NOx/ peak four quarters)	**Low** (24 tons NOx/ peak four quarters)
Truck Traffic Noise	NA	Residences on truck route approaching site	No residences on truck route approaching site	Truck route through residential area approaching site	Very few residences on truck route approaching the site
Truck Miles	5,600,000	7,800,000	30,500,000	9,500,000	3,400,000
Landfill Operation Noise	No impact	No residences within 600 ft of landfill operations	No residences within 600 ft of landfill operations	No residences within 600 ft of landfill operations	High. 7 residences within 100 ft, 30 within 400 ft, and over 100 within 600 ft of the landfill operations. Daytime noise increases of 20dB(A)Leq or more

* Impacts of truck traffic to the barge loading facilities are not quantified because the traffic is within the Project right-of-way for much of the route. The remainder of the route, which is on city streets, is generally common to the routes to inland sites and thus was not quantified as part of the traffic impacts to the inland sites.

landfills under the Solid Waste Act of 1987 (c.111, s.150A and s.150A 1/2) and 310 CMR 16.00. During the past decade, environmental contamination from local landfills resulting from improper siting, substandard design, and poor operations has emerged as a serious public health and natural resources preservation concern statewide. Thus, solid waste siting and management considerations are a key impact area affecting alternative materials disposal approaches at both the overall policy planning level and at the level of regulation of specific sites. These considerations affect all of the alternative disposal approaches involving new inland landfills.

Creation of any new dedicated landfills for disposal of Artery/Tunnel excavate would be regulated as a general solid waste landfill facility under applicable Massachusetts statutes and regulations particularly in light of the physical and chemical contaminants present in the historic fills to be excavated by the project.

At the overall policy level, the DEP is seeking to implement plans to address the critical shortage of safe and adequate solid waste disposal facilities in the state. The Commonwealth of Massachusetts currently has very limited existing landfill capacity, a situation which is expected to worsen over the next ten years as the great majority of remaining existing municipal landfills are forced to close because of exhausted landfill capacity and/or environmental contamination problems. Moreover, DEP's overall goal is to eliminate direct disposal of solid waste at all landfills because of the difficulty, even using new technologies, of controlling the serious forms of water and air pollution that characterize land-based waste disposal.

(In DEP's integrated statewide plan, landfills would optimally be used after year 2000 only for those specialized wastes, namely bypass and residues from processing facilities, which cannot be reasonably reduced, recycled, or burned.)

For reasons of both the extremely limited existing viable landfill capacity, and the state's plans to eliminate most landfill use during the coming decade, DEP has strongly opposed utilizing inland landfills critically needed for other types of solid waste for Artery/Tunnel project fill and excavate which can potentially go elsewhere. The comparison of alternative disposal approaches involving extensive development of new inland landfills against using principally Spectacle Island for Artery/Tunnel materials disposal must be seen in this context.

The capping and containment of the historic inactive landfill at Spectacle Island is itself consistent with the Commonwealth's program to clean up, close, and seal inferior landfills. Project studies to date have demonstrated that the project's materials are of suitable quality for disposal in a contained marine site, and that proper capping and drainage design can effectively control both leachate from the existing landfill on Spectacle Island and from the new fill material to be generated by the project.

In summary, DEP's policy direction of reserving scarce future landfill capacity for specialized forms of solid waste makes approval of new general-use landfills unlikely. Under these circumstances, environmental considerations relating to overall solid waste management would generally favor the predominantly Spectacle Island disposal approach as the environmentally preferable solution.

4.9.4(c) Construction Phase Environmental Impacts

Regional Traffic, Air And Related Impacts. All approaches involve truck trips and traffic impacts to some degree. Approximately 1200 truck trips per day must take place, either to a disposal site directly, to a barge site directly, or to a conveyor system going to a barge.

Initial impacts within the right-of-way exist for all disposal approaches. However, additional impacts come with the use of inland disposal sites and routes to them. With greater use of inland sites, the greater the truck miles, engine emissions into the air, and potential dust and dirt impacts on the roadway.

As shown on Table 4.17, the number of truck miles from any one of the inland sites is an extraordinary number (from 3.4 million to 20.5 million truck miles). With the predominantly inland approach, the total is about 51 million truck miles, compared to the approximately 5.6 million truck miles for the predominantly Spectacle Island approach. Thus, the inland approach would cause an unusual degree of construction traffic impact on the Central Artery, and other regional connectors over the span of the excavation for the project.

The extraordinary scale of this project, including the large number of truck trips and truck miles, place safety on the list of important concerns. The range of 5 to 51 million truck miles leads to a range of potential safety issues. These are affected by the distance, roadway conditions, type of traffic along the route, etc. Statistics suggest approximately 3 more fatalities just from the mileage increase from 5 to 51 million miles. The use of heavily laden trucks around the clock in sometimes congested local traffic and foul weather conditions may cause this figure to rise.

Local Traffic, Air, Noise, And Operational Impacts. The initial impacts within excavation work areas are the same for all disposal approaches. Additional impacts would be associated with use of inland disposal sites and the routes to them.

One of the critical issues associated with the localized impacts relates to the sheer magnitude of the material transport and disposal program. Impacts to local communities from the disposal of 2.4 million cubic yards at a single inland disposal site would involve 100 one-way truck trips per day over a seven year period and the associated noise, air quality, safety, and congestion impacts on local streets. Increases in average daily truck traffic on primary roads would range from an increase of 20 to 364 percent and on local roads up to 259 percent.

The landfilling operation would generate noise levels of up to 80 dBA six hundred feet from the site. Even if use of the inland sites were restricted to daylight hours, noticeable increases in noise levels would be present over wide areas surrounding the disposal sites. Substantial quantities of leachate and runoff containing high levels of sodium and chlorides would be generated during the landfilling period before the final cap would be in place.

In contrast, the use of Spectacle Island for disposal of the fill, unsorted clay and till, and unacceptable dredge would not impact any residential areas during the construction period and runoff containing sodium and chlorides would not affect surrounding marine waters.

4.9.5 Environmental Impacts Of Alternative Disposal Approaches

This section assesses the environmental impacts of each of the five alternative disposal approaches that were described in Section 4.9.3. In this discussion, various positive and negative environmental impacts are viewed collectively in order to present a composite picture of each disposal approach considered. See Section 4.8 of this chapter for a more detailed assessment of changes in conditions at the individual disposal sites (Spectacle Island and the four inland sites included in the alternative approaches) which would occur if they were used for Project materials disposal.

4.9.5(a) Predominantly Inland Approach

All four inland sites which were evaluated for disposal of project materials are included in this approach. Each site was reviewed for wetland content, and areas where disposal would impact on aquatic resources were delineated and avoided when practicable. However, it should be emphasized that the quantities of material that must be disposed make it extremely difficult to completely avoid areas regulated under Section 404 of the Clean Water Act.

The capacities of the sites were calculated using basic landfill siting criteria including liners, caps, topsoil, leachate collection and treatment, runoff collection and treatment, site preparation, contractors laydown requirements, and access. In summary, the total capacity of the four sites was 13,817,000 cy, of which 10,201,000 cy would be material from the project. The difference is granular material required for drainage, and leachate collection, topsoil; access road material and clay material becomes available (project clay is overlaid by the fill material requiring disposal in the landfill).

A review of the Project requirements for the disposal of various materials indicates that there would be a small capacity shortfall for the fill material and the native clay and till. However, additional site capacity could be achieved by minimally increasing the height of fill at one or more sites. The inland disposal approach assumes that the additional site capacity has been achieved in this way. If the four inland sites were used in this manner, the resulting disposal scenario would preclude any possibility of mobilizing sufficient project material to cap the Spectacle Island landfill, and Spectacle would not be used for any disposal.

As described in previous sections environmental conditions at each inland site suggest that impacts of increased rank order would result with the sequential filling of Malden, Weymouth, East Brookfield, and Bedford. Disposal of 9.3 million cy would largely fill the footprints of all four of those sites. This inland approach has substantial and unavoidable environmental consequences related to the development, isolation, operation, and maintenance of each landfill site (Table 4.17). The combined use of these inland sites would fill about 290 acres and eliminate over 90 acres of inland wetlands regionally. Trucking materials to these sites would create an additional environmental burden of noise and traffic impacts to areas abutting transit corridors and landfill operations. Traffic on local roads would substantially increase along the Weymouth and East Brookfield routes (Table 4.17). The Malden site fares better in some aspects of traffic impact because of nearly direct access from Route 1; however, there are 100 residences located within 600 feet of the site. The first row in Table 4.18 summarizes impacts associated with using these inland sites, and the impacts are cumulative when using a truck-oriented approach.

An evaluation of the potential of these sites to comply with the Commonwealth's landfill siting criteria in 310 CMR 16.00 indicates that landfill siting criteria may not be met at these locations. More specifically, potential landfill sites at Bedford and East Brookfield are situated adjacent to, or within, areas providing drinking water supplies; this creates concern for the transport of leachate from the site groundwater via the foundation soils. Even with a composite liner at the base of the landfill, high or fluctuating groundwater tables would make the closure system less secure. This is the case at the Bedford site and also the two quarry sites, Weymouth and Malden. Rock fissuring in the rock quarry floors would be impracticable to seal with today's technology. The alternative would be to provide adequate drainage between the rock and the composite liner of the landfill.

The use of two inland sites in particular (Bedford and East Brookfield) would contribute to substantial loss of diverse inland wetland habitat. While Bedford would allow for the disposal of 2.1 million cy of material, it results in the loss of 58 acres of wetland and exposes groundwater within a Zone II well field delineation to unneeded risk of contamination. Disposal at East Brookfield would result in the loss of 20 acres of inland wetland and would disrupt a diverse and relatively contiguous wildlife habitat resource. Surface waters at both locations would likely be affected by drainage discharge during site preparation. Additionally, the relative isolation of East Brookfield particularly contributes to its value as wildlife habitat. The loss of wetlands and diverse transitional (mixed) forests, and possible impacts to groundwater and surface (nontidal) waters, are considered substantial environmental impacts associated with the use of these sites.

4.9.5(b) Combined Approach With Spectacle Island Capping (Three Or Four Inland Sites)

Using some project material for capping the Spectacle Island landfill would eliminate the use of at least one inland site, provide another disposal outlet, and better isolate the Harbor from materials leaching and eroding from an unclosed landfill. Considering the historic use and present condition of the island, closure appears warranted; however, stabilization of the landfill is not without environmental consequence. The island is remote from residential areas and would be available throughout the project construction period. There would be no traffic, noise, or air quality impacts on any residences (Table 4.17). No substantial impact on wave patterns, currents, or shipping channels in the Harbor would result from enlarging the island. With Spectacle Island's landfill as a component of the disposal scenario, the number of inland disposal areas can possibly be reduced to three, thereby limiting somewhat the reduction of regional lowland areas.

Capping the Spectacle Island landfill could require as little as 0.8 million cy of excavated and dredged material. However, capping requires the stabilization of eroded shores with rock revetment, clay cap, and rock dike. While isolation of the landfill from the Harbor is an environmental improvement, that process alone replaces some intertidal areas with rock and fill. Lost natural habitat, however, would result in landfill closure and a rock revetment intertidal/subtidal region available for subsequent colonization. Capping, or island enlargement, would also increase aquatic-associated terrestrial habitat, coastal bank, and rocky subtidal shore (Table 4.15).

Since capping and stabilization of Spectacle Island should be done for environmental reasons, regardless of the Central Artery/Tunnel Project, the appropriate baseline for comparison is a capped and stabilized island, rather than the existing landfill which continues to erode into the Harbor. The aquatic impacts of this minimum baseline can be seen in the combined approach being described here. Capping would displace 10 acres of the existing shellfish habitat, 8 acres of the coastal beach, and 9 acres of the rocky intertidal shoreline; it also would fill 9 acres of land under the ocean (Table 4.16). Capping Spectacle Island would also require rock dikes to stabilize eroding banks, and these would increase the length of coastal bank and add rocky subtidal shoreline. As noted in Table 4.16, the resulting net aquatic impacts of only capping Spectacle are similar to the impacts on most aquatic resources for other alternative approaches including full use of Spectacle. In all alternatives utilizing Spectacle, coastal wetlands and coastal beach are increased to an approximately comparable degree, and the amount of rocky subtidal shoreline and coastal bank are increased to varying degrees. In all approaches involving Spectacle, there is some loss of land containing shellfish and coastal beach to an approximately comparable degree. The most notable aquatic impact difference between capping Spectacle and fully using Spectacle is loss of an additional 68 acres of an abundant habitat (land under the ocean) in the latter approach. With the exception of this one resource area, however, nearly all the aquatic impacts resulting from Spectacle's use for materials disposal occur principally as a result of capping and containing the island's landfill.

The aquatic impacts of various disposal approaches using Spectacle Island must be balanced against the wetlands filling and related aquatic and biological impacts while using one or more of the inland sites evaluated. Review of the trade-offs of incremental increases in island size (beyond capping only) against reductions in environmental disturbance at the inland site has been performed using the impact data generated for this chapter, and is summarized in Table 4.18. Analysis suggests that incremental increases in volume at Spectacle Island above the amount necessary to cap the island can be translated into substantial environmental benefits, by reducing collective (cumulative) projectwide impacts (see Table 4.18).

4.9.5(c) Combined Approach (Two Inland Sites)

If an intermediate-sized Spectacle Island was considered as a disposal alternative (Footprint 2, Figure 4.44), this could contain materials approximately equal to the capacity of the two inland sites raising the greatest environmental concerns (Bedford and East Brookfield). This scenario would use Weymouth and Malden as disposal sites in combination with Spectacle Island. The cumulative impact using this disposal scenario (Table 4.18, Row C) would avoid all impacts associated with Bedford and East Brookfield disposal sites, particularly the impairment of one to three Zone II drinking water well areas, 78 acres of inland wetlands, and 60 acres of transitional uplands. The use of the Weymouth site would nevertheless involve loss of 12 acres of wetland, and traffic, air, and noise impacts associated with 9,500,000 truck miles (see Table 4.17 and also Table 4.18, Row C).

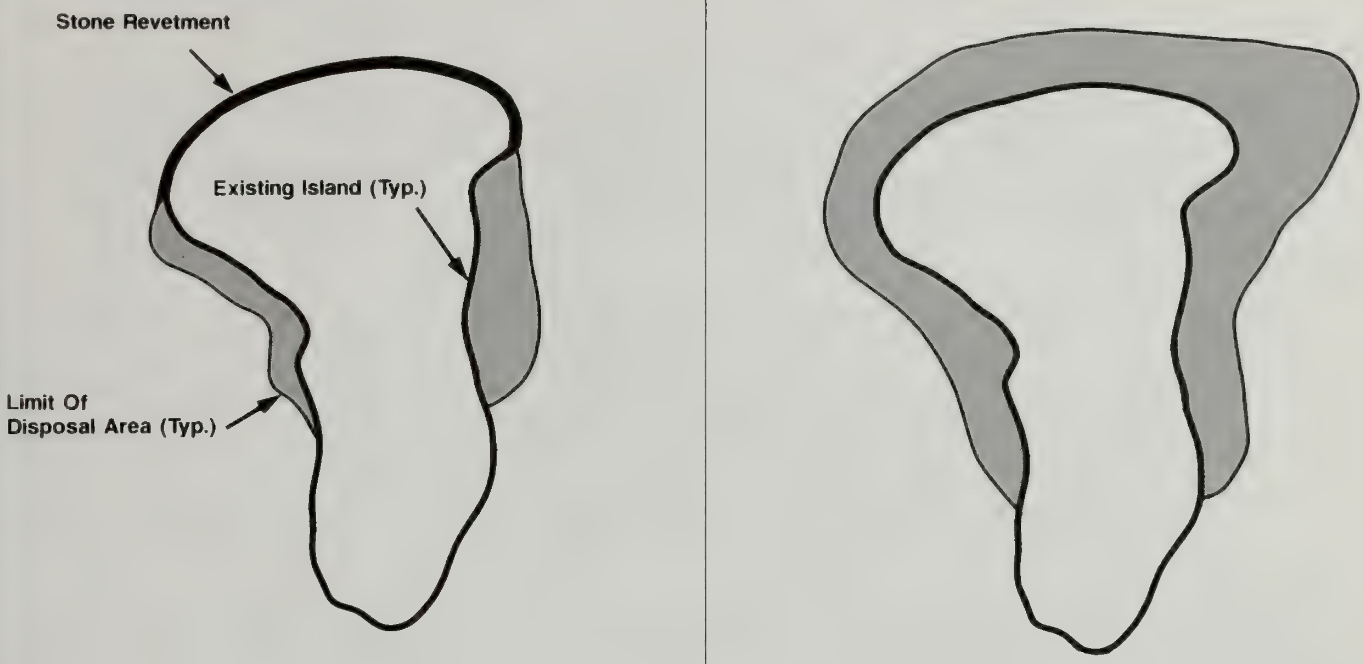
4.9.5(d) Combined Approach (One Inland Site)

A second intermediate-sized island considered would be capable of handling all materials proposed for Weymouth. This relatively small net increase in island size (Footprint 3, Figure 4.44) would have a net beneficial effect by reducing the projectwide environmental impact (see Table 4.16). This scenario would result in limiting the project's disposal program to one inland site of poorest environmental quality, the Malden quarry site, with little incremental impact to existing conditions at Spectacle Island. A scenario using only one inland site, Malden, allows for the creation of substantially greater terrestrial habitat at Spectacle Island and the establishment of more stable conditions along the island's shore for invertebrate colonization (see Table 4.18, Rocky Intertidal and Subtidal

Table 4.18

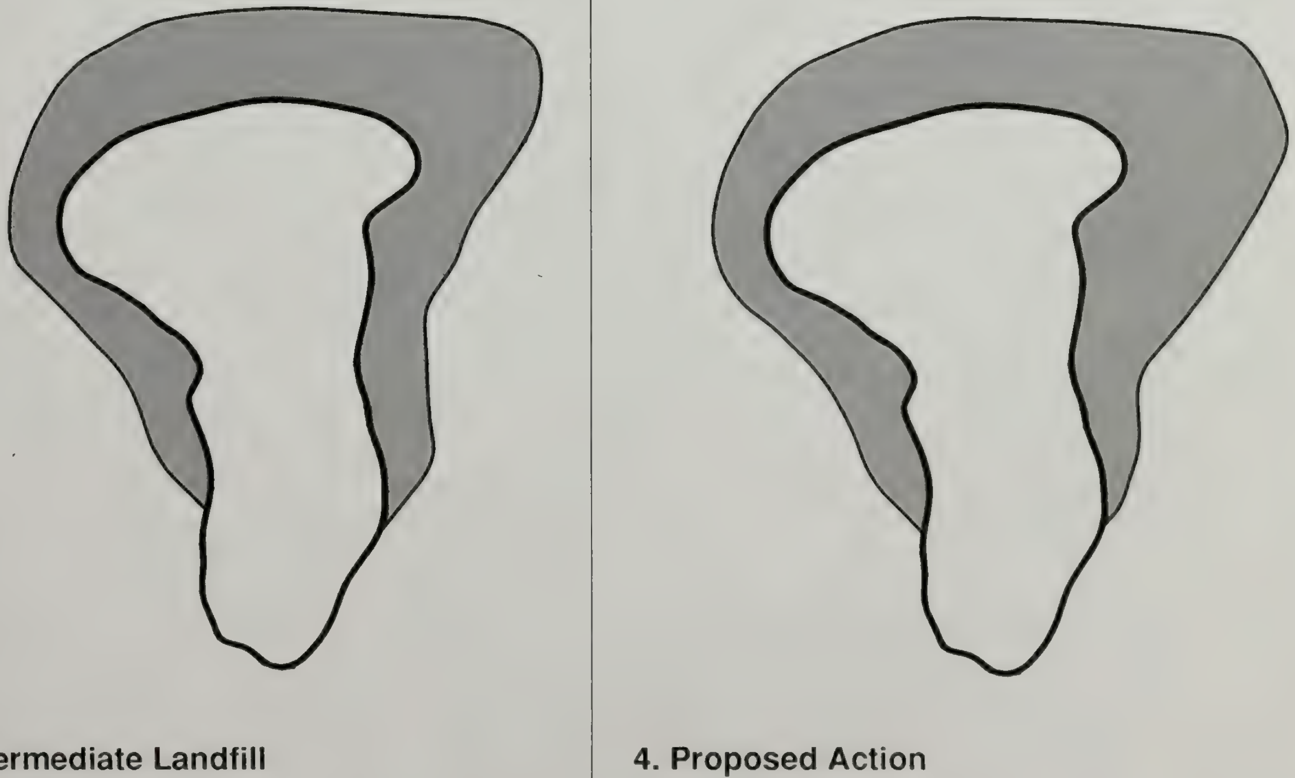
COMPOSITE OF DISPOSAL SITES/IMPACTS

Materials Disposal Approaches:	Sites Affected: *Spectacle Island*	*Malden*	*Weymouth*	*E. Brookfield*	*Bedford*
(a) **Inland Approach**	**Benefits:** None (no Island capping, no park created) **Impacts:** Continued adverse effects on harbor water quality from Island landfill **Other:** No change in the existing aquatic resources	**Benefits:** Improvement of existing quarry habitat **Impacts:** Some potential of leakage to coastal wetland Residences directly impacted by noise during operations Substantial truck related impacts Quarry business relocation 0.4 acres of inland wetlands filled	**Benefits:** None **Impacts:** 5 acre pond impacted 12 acres of wetlands filled/at risk Some risk of leakage to public water supply wells Residences, school directly impacted by noise along truck route Substantial truck-related impacts	**Benefits:** None **Impacts:** 20 acres of wetlands filled/at risk Some risk of leakage to river, two municipal water supply wells 60 acres of upland and transitional wooded habitat replaced Residences, directly impacted by noise, operations, truck route Substantial truck related impacts	**Benefits:** None **Impacts:** Zone II delineation of adjacent wells Loss of 58 acres of inland wetlands Loss of upland habitat
(b) **Combined Approach With Spectacle Island Capping**	**Benefits:** Landfill capped Park created 200 ft increase in coastal bank 2 acres coastal wetland created 1/3 acre rocky subtidal shore created **Impacts:** 1/5 acre coastal wetland filled 7 acres coastal beach removed 8 acres rocky intertidal shore removed 10 acres of shellfish flat disturbed No water quality impacts Minimal noise	**Benefits:** Improvement of existing quarry habitat **Impacts:** Some potential for leakage to coastal wetland Residences directly impacted by noise during operations Substantial truck-related impacts Quarry business relocation 0.4 acres of inland wetlands filled	**Benefits:** None **Impacts:** 5 acre pond impacted 12 acres wetlands filled Some risk of leakage to public water supply wells Residences, school directly impacted by noise along truck route Substantial truck-related impacts	**Benefits:** None **Impacts:** 20 acres of wetlands filled/at risk Some risk of leakage to river, two municipal water supply wells 60 acres of upland and transitional wooded habitat replaced Residences directly impacted by noise along truck route Substantial truck-related impacts	**Benefits:** None **Impacts:** None
(c) **Combined Approach (Two Inland Sites; Spectacle Island)**	**Benefits:** Landfill capped Park created 1300 ft increase in coastal bank 2 acres coastal wetland created 4 acres rocky subtidal shore created **Impacts:** 1/5 acres coastal wetland filled 7 acres coastal beach removed 14 acres rocky intertidal shore disturbed 13 acres of shellfish flat disturbed No water quality impacts Minimal noise Reduced truck-related impacts	**Benefits:** Improvement of existing quarry habitat **Impacts:** Some potential for leakage to coastal wetland Residences directly impacted by noise during operations Substantial truck-related impacts Quarry business relocation 0.4 acres of inland wetlands filled	**Benefits:** None **Impacts:** 5 acre pond impacted 12 acres wetlands filled Some risk of leakage to public water supply wells Residences, school directly impacted by noise along truck route Substantial truck-related impacts	**Benefits:** None **Impacts:** None (unless substituted for Weymouth Site)	**Benefits:** None **Impacts:** None
(d) **Combined Approach (One Inland Site; Spectacle Island)**	**Benefits:** Landfill capped Park created 1700 ft increase in coastal bank 2 acres coastal wetland created 12 acres rocky subtidal shore created **Impacts:** 1/5 acre coastal wetland filled 7 acres coastal beach removed 14 acres rocky intertidal shore disturbed 13 acres of shellfish flat disturbed No water quality impacts Minimal noise Reduced truck-related impacts	**Benefits:** Improvement of existing quarry habitat **Impacts:** Some potential for leakage to coastal wetland Residences directly impacted by noise during operations Substantial truck-related impacts Quarry business relocation 0.4 acres of inland wetlands filled	**Benefits:** None **Impacts:** None	**Benefits:** None **Impacts:** None	**Benefits:** None **Impacts:** None
(e) **Spectacle Approach**	**Benefits:** Landfill capped Park created 2600 ft increase in coastal bank 2 acres coastal wetland created 12 acres rocky subtidal shore created **Impacts:** 1/5 acre coastal wetland filled 7 acres coastal beach removed 14 acres rocky intertidal shore disturbed 13 acres of shellfish flat disturbed No water quality impacts Minimal noise Least truck-related impacts	**Benefits:** None **Impacts:** None	**Benefits:** None **Impacts:** None	**Benefits:** None **Impacts:** None	**Benefits:** None **Impacts:** None



1. Capping Landfill Only
(2.2 million cu. yds.)

2. Intermediate Landfill
(4.8 million cu. yds.)



3. Intermediate Landfill
(6.9 million cu. yds.)

4. Proposed Action
(9.3 million cu. yds.)

FIGURE
4.44 Footprints Of Disposal Alternatives At Spectacle Island

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Shoreline). The use of the Spectacle Island for additional material, equivalent to a third inland site's capacity, only impacts 13 acres of land beneath the ocean, while further contributing to terrestrial habitat and substantially increasing rocky subtidal shore for subsequent colonization. Consequently, 12 acres of inland wetland at Weymouth would be avoided.

However, the adverse community and site-specific environmental impacts of using Malden remain substantial. For example, consequential noise impacts would result because of the proximity of the site to numerous residences. Other concerns include the potential that this site is a source of reported groundwater contamination. Such contamination could require hazardous materials cleanup with its own potential environmental impacts before the site could be used for disposal. This possibility also has indirect ramifications, in that it suggests that fissured rock may provide a conduit from the excavated fill to groundwater.

4.9.5(e) Predominantly Spectacle Approach

The final disposal scenario for consideration would utilize only the Spectacle Island landfill for disposal. The only differences in marine impacts resulting from use of Spectacle Island alone, rather than in combination with one or two inland sites, would be the reduction in land under deeper ocean waters by 12 to 25 acres. Shallower water habitats would be unchanged and benefits such as additional coastal bank and rocky intertidal habitat would be created.

Full use of Spectacle would fill an additional 68 acres of land under the ocean, beyond that required for capping. It would also displace an additional 3 acres of land containing shellfish and 5 acres of rocky intertidal shoreline. However, this approach would offset those habitat losses by increasing the area of coastal wetlands from 0.2 existing (which is displaced by capping) to 2.0 acres, increasing rocky subtidal habitat by 12 acres, and increasing the length of coastal bank by 2,400 linear feet over that achieved by capping alone. Coastal beach would also be more abundant following the predominantly Spectacle approach than it would be with landfill capping only. The incremental loss of existing habitats and aquatic resources is low once proceeding past initial landfill capping at Spectacle Island. The difference between an all-Spectacle approach and the capping action can be summarized as a loss of 68 acres of land under deeper water versus a substantial increase in shoreline, rocky subtidal habitat, and a stable rocky intertidal zone.

The use of Spectacle Island alone would eliminate all inland disposal environmental impacts to wetlands, open water, upland forests, and valuable (limited) isolated wildlife habitats. Sites which presently may not exhibit such habitat diversity would have the opportunity to be either reclaimed or proceed through natural succession (if they remain undeveloped). Furthermore, a projectwide reduction of over 46,000,000 truck miles and associated road and traffic impacts would be realized by this disposal approach.

Environmental impacts would be limited with incremental increases in Spectacle Island's capacity following capping of the landfill. Additionally, use of the Spectacle Island landfill, unlike most fill areas, allows for a positive net change in environmental conditions at the site. Loss of original aquatic habitat at Spectacle Island generally would be followed by the creation of new habitats for colonization. The net environmental benefits resulting from the island's full use, rather than use of an inland site makes a predominantly Spectacle Island approach environmentally preferable.

4.9.6 Costs

As described throughout this chapter of the SEIS/R, the overriding factors used in studying disposal options have been those that relate to the environment. In addition, precise cost estimates could not be made until final design of the actual disposal sites is completed. However, a preliminary review of costs for the alternative disposal approaches was made. Common costs, such as the disposal of clean dredged material at an ocean site, were not included for this purpose because this material would presumably be disposed at the MBDS.

Major costs are associated with both inland and Spectacle disposal approaches. In the approaches using inland sites, major public investment is required to create and appropriately line and contain large new landfills. Also, provisions must be made for roads and other site infrastructure. The potential restriction on 24-hour use of inland landfill sites, requires stockpiling of project materials and double handling, that would add substantially to the cost of using inland sites. In the approaches using Spectacle Island, there are high initial costs of constructing barge terminal facilities and dikes; costs of using Spectacle Island would increase on a per yard basis as the amount of disposal permitted there is reduced. Costs of using inland sites would increase as more material was allocated in that direction, since smaller sites would be needed and the geometric relationship between circumference, area, and volume would require a higher ratio of capping and lining to contain material at each site.

The results of the preliminary cost estimates indicate that the predominantly inland disposal approach would cost approximately 16 percent more than the predominantly Spectacle approach.

Two related indirect cost implications of the alternative approaches should also be noted. First, in the predominantly inland option, approximately 70 percent of the clean clay and till would be used to enclose the project materials requiring disposal. In the Spectacle option, approximately 20 percent of the same material would be used. Thus, the availability for use of this clean clay and till for capping existing or future sanitary landfills would be greatly reduced with inland disposal. The volume of material not available for public use would be approximately 1,500,000 cy, which would be sufficient to cap 13,500,000 square feet of landfills. Second, the capping and containment of the eroding existing landfill on Spectacle Island is estimated to cost approximately $75 million. This cost, if not incurred by the Project's materials disposal program, will need to be provided by the Department of Environmental Management and/or the City of Boston to cap the existing landfill.

4.9.7 Summary Of Comparison Of Alternative Disposal Approaches

The preceding sections have assembled and compared information on multiple disposal approaches for the Project's excavated fill, mixed clay/fill, and unacceptable dredged materials. These approaches range from the inland approach, in which all such material is placed at inland sites, to the Spectacle approach, in which all difficult to dispose material is located on Spectacle Island. Intermediate approaches would use Spectacle Island to a lesser extent in combination with one, two or three inland sites.

Given an 80-acre minimum size, a minimum of four inland sites would be required in lieu of disposal at Spectacle Island. However, three of the four sites identified contain freshwater wetlands that would either be filled or would require substantial reduction in the disposal capacity of those inland sites. Additionally, there would be noise, water quality, and truck-traffic impacts associated with use of those sites. This chapter has compared impacts from the best available inland sites (i.e., those passing the initial screen); utilizing less desirable sites would mean correspondingly greater impacts for inland areas.

With any approach involving use of Spectacle Island, much of the existing shoreline and intertidal habitats at Spectacle Island would be replaced, and varying amounts of land under the ocean would be filled. However, such an approach would have the considerable benefit of creating an expanded and stable aquatic and ecological resource at Spectacle Island. For example, there would be increased coastal bank, an expanded aquatic-associated terrestrial habitat, stable rocky inter- and sub-tidal zones, and isolation of the existing landfill from Harbor waters. Additionally, a predominantly Spectacle approach would avoid noise, traffic, air pollution, and other impacts to residential areas, reduce the regional impacts associated with truck transport of material from central areas of Boston to inland sites, and avoid impacts on sensitive groundwater supply areas. Finally, the use of Spectacle Island allows for the creation of a uniquely valuable public waterfront park area, long planned as a part of the Boston Harbor Islands State Park.

The net combined benefits and impacts on Spectacle Island under the predominantly Spectacle disposal approach make it the environmentally preferred approach for incorporation into the Proposed Action in comparison to combinations of inland sites.

4.10 THE PROPOSED ACTION

The analyses presented in the previous sections were used to make recommendations on the disposal sites for each of the types and quantities of material to be dredged or excavated by the project. These recommendations, taken as a group, describe the materials disposal approach selected for design study as part of the Department's Proposed Action for the Central Artery/Tunnel Project:

1,205,000 cy to Massachusetts Bay Disposal Site (MBDS)
2,666,000 cy to sanitary landfills
9,283,000 cy to Spectacle Island
379,000 cy to landfills

Total **13,533,000 cy**

These totals can be broken into material types as follows:

MBDS: 1,205,000 cy of acceptable dredged material

Landfills: 2,666,000 cy of acceptable clay and till for capping
379,000 cy to landfills

Spectacle Island: 1,010,000 cy of unacceptable dredged material
800,000 cy of acceptable clay and till for capping
7,272,000 cy fill, clay, till and other excavated materials
201,000 cy dredged rock

Total **13,533,000 cy**

This approach contains the following elements:

- The acceptable clay and till can be most advantageously used to cap existing landfills, especially those which drain to a marine environment. The Proposed Action would provide beneficial use of this material at many coastal landfills and at Spectacle Island.

- The fill, unsorted clay and till, unacceptable dredged and other excavated materials would be disposed at the contained marine site at Spectacle Island. Disposal of this material at inland landfill sites or in the ocean has been shown to be either impracticable or environmentally unacceptable.

- The Proposed Action would provide capping of the existing landfill and stabilization of the Island which is necessary to implement the Boston Harbor Islands State Park Master Plan (1986). The Island's landowners, the Massachusetts Department of Environmental Management (DEM) and the City of Boston support use of Spectacle Island for the project's material disposal in order to create usable parkland on the Island.

- The acceptable dredged material would be disposed at the designated ocean disposal site. It would be placed directly onto barges with no impact on regional city street traffic.

4.11 POTENTIAL SUPPLEMENTARY DISPOSAL UNDER INVESTIGATION AT LOGAN AIRPORT

Coordination regarding inland alternatives continues under the 404(b)(1) process with the Corps of Engineers. Should inland capacity be found that is practicable and environmentally acceptable in light of overall public purposes, the amount of fill targeted for Spectacle Island could be correspondingly reduced.

In this spirit, the Project has identified a potential use of project material for modification to the infield at Logan Airport. This would involve leveling currently depressed infield areas between runways and taxiways with a yet-to-be-determined volume of material. The material would *not* be used for airport expansion into Boston Harbor and would be used entirely within the existing limits of the airport.

The Department is considering these runway infield areas as potential disposal locations sites (see Figure 4.45) for some of the excavated materials generated by construction of the Artery/Tunnel Project.

Materials excavated on Massport properties in East Boston could be transported by truck directly through the Massport property without using streets in residential areas. In

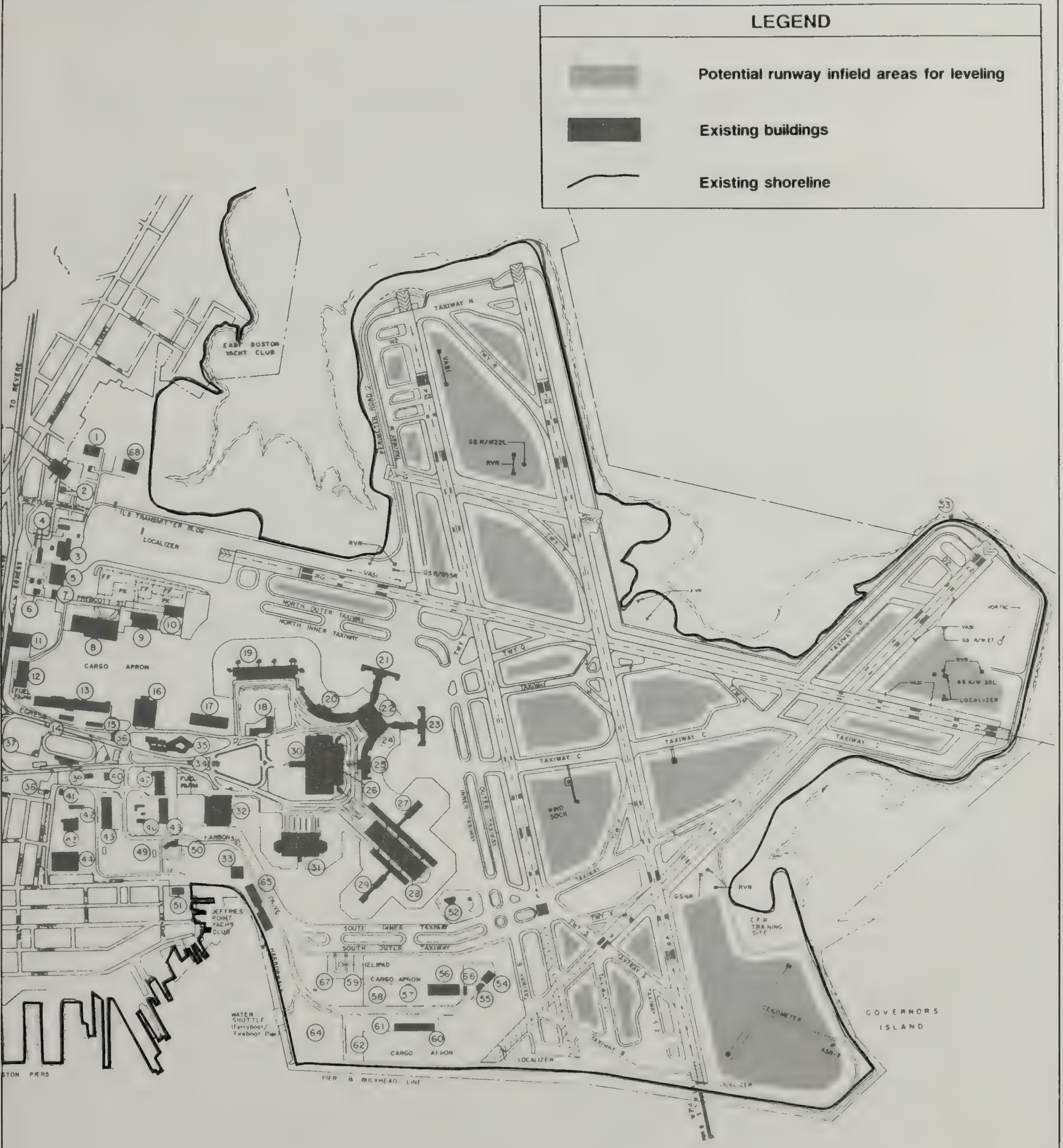


FIGURE 4.45

Potential Areas For Leveling At Logan Airport

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 1000 2000 Feet

addition, because of the site's proximity to the Harbor, material from other areas of the Project could potentially be transported to Logan by barge.

The logistical and environmental feasibility of this proposal will be assessed more fully before a course of action is recommended. An obvious concern is coordination with airfield operations, but such coordination and control of trucks in the airfield would be similar to that frequently required for airfield operation. A second concern would be relocation of existing drainage and airfield operations equipment affected by this proposal. Since a variety of infield areas would be involved, disposal operations would be shifted in relation to the pattern of runways in use at a given time. Availability of the Logan infield site could also provide additional flexibility to maintain disposal operations when other sites might become unavailable because of weather or traffic conditions.

If proven feasible, the disposal of material at Logan Airport could have substantially less environmental impact than the other inland sites evaluated. Filling of wetlands would not be an issue as is the case at the Bedford, East Brookfield, and Weymouth sites, nor is the salinity of material excavated from the Harbor area a problem. There are no public water supplies in the vicinity of the airport as occur near the Bedford and East Brookfield disposal sites. Disposal of materials at Logan would not adversely affect the groundwater which could be the case at Malden. Noise impacts, such as those evident at Malden, would be substantially less at the airport (because of greater distances from residential areas and higher background noise), and transportation impacts as a whole would be substantially less than those for inland sites because of the airport's proximity to the excavation sites.

The site could, if feasible, augment the multiple site approach for materials disposal incorporated in the Proposed Action.

Part IIC – Other Design Refinements

Part IIC

OTHER DESIGN REFINEMENTS

INTRODUCTION

This chapter describes, largely in matrix and graphic form, the evolution of 17 modifications to the Artery/Tunnel Project evaluated in this SEIS/R in comparison to the Preferred Alternative in the 1985 FEIS/R. These modifications are located throughout the project alignment and include a number of Central Artery ramps, several interchanges, and the alignment of the I-93 northbound mainline and the Third Harbor Tunnel.

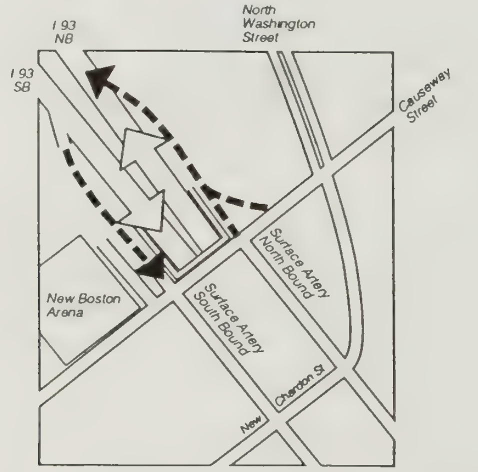
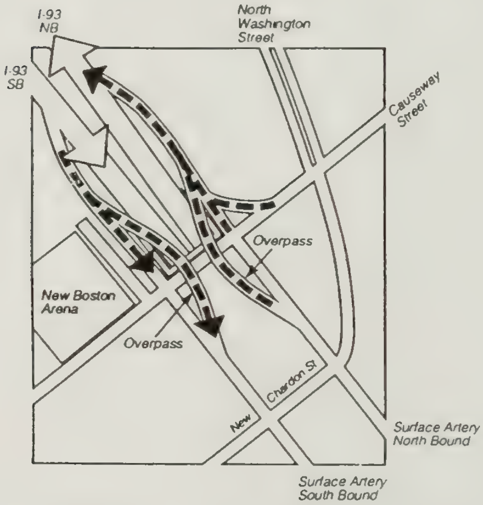
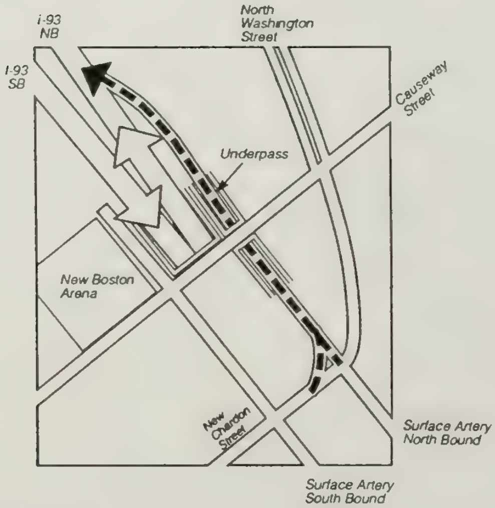
Each project element described has at least three design options: The FEIS/R concept, one or more interim or revised options, and finally, the Proposed Action. The major characteristics of each of these is described in the matrices and each is also accompanied by a graphic. The various options for each element are compared in the matrices against five groups of design criteria: Traffic and Transportation; Water, Air, Noise Impacts; Land Use/Urban Design; Parkland and Historic Resources; and Construction.

Traffic and Transportation includes geometric design consideration, safety concerns, traffic volumes and operations, and relationship to, or impacts on, other transportation modes. Water, Air, Noise Impacts are self-explanatory, except that the information provided is comparative as detailed analysis was not conducted on all options. Land Use/Urban Design includes right-of-way takings and other less direct land use impacts, economic impacts such as loss of jobs, visual and aesthetic impacts, pedestrian access considerations, and impacts on the development of joint development parcels. Parkland and Historic Resources refers to impacts on parks and open spaces in or near the alignment and to direct or indirect impacts to historic buildings, historic districts, or historic bridges. Construction has the least developed cells of the matrix as the constructibility of many of these options was not pursued due to other flaws which removed them from consideration before constructibility review.

The list of other design refinements is as follows:

1. I-93 Southbound Off-Ramp to Causeway Street Area
2. I-93 Northbound On-Ramp from Causeway Street Area
3. I-93 Southbound Off-Ramp to Government Center Area
4. I-93 Southbound On-Ramp from Government Center Area and On-Ramps to Callahan Tunnel
5. I-93 Northbound Off-Ramp to Government Center Are
6. I-93 Southbound Off-Ramp to Financial District
7. I-93 Northbound Off-ramp to Financial District
8. I-93 Northbound On-Ramp from Northern Avenue
9. I-93 Northbound Alignment - South Station Area
10. I-93/I-90 Interchange Major Connectors
11. Local Street Reconstruction in I-93/I-90 Interchange Area
12. Massachusetts Avenue Interchange
13. I-90 Mainline Alignment - South Boston
14. Third Harbor Tunnel Alignment - South Boston
15. Logan Airport Interchange - East Boston
16. Connections to Route 1A Northbound - East Boston
17. Connections to MBTA Blue Line Airport Station - East Boston

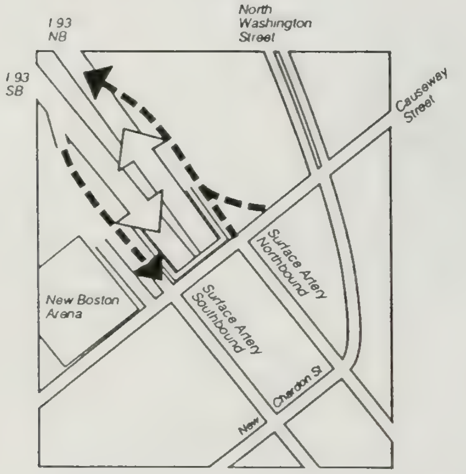
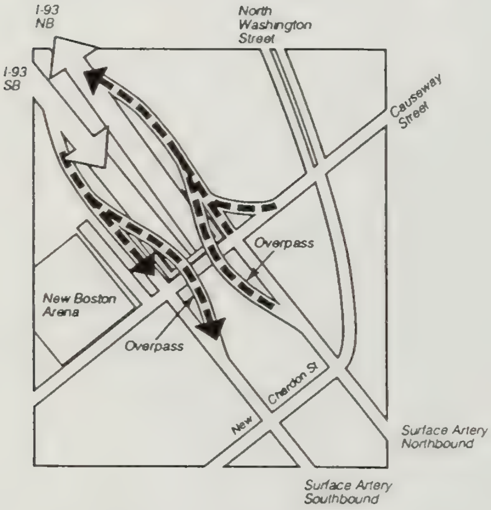
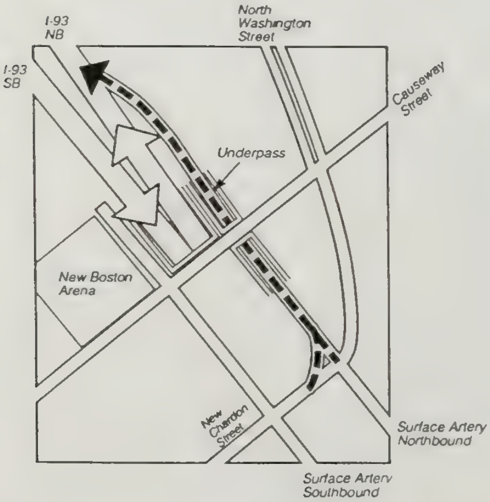
1 • I-93 SOUTHBOUND OFF-RAMP TO CAUSEWAY STREET AREA

	Design Options	Traffic and Transportation
 I 93 NB North Washington Street I 93 SB Causeway Street Surface Artery North Bound Surface Artery South Bound New Boston Arena Chardon St New	**FEIS/R** Off-ramp to Causeway Street from I-93 Southbound mainline	Creates substandard weave on I-93 southbou mainline Adds traffic to Causew Street and to southbou surface artery Provides direct access for buses to proposed MBTA bus station and garage on Canal Street Provides good exit for flammable materials trucks before Central Artery tunnels
 I-93 NB North Washington Street I-93 SB Causeway Street Overpass New Boston Arena Overpass Chardon St New Surface Artery North Bound Surface Artery South Bound	**Fly-Over Scheme** Off-ramp to Traverse Street on elevated viaduct over Causeway Street and off-ramp to Causeway Street	Creates substandard weave on I-93 southbou mainline Permits some southbou traffic to bypass Causeway Street Adds traffic to southbound surface artery
 I-93 NB North Washington Street I-93 SB Causeway Street Underpass New Boston Arena New Chardon Street Surface Artery North Bound Surface Artery South Bound	**Proposed Action** No Causeway Street off-ramp Access to North Station area by Nashua Street off-ramp and Charlestown Bridge Access to Government Center area by Clinton Street off-ramp	Eliminates substandard weave on I-93 southbou Facilitates balanced access to North Station and Government Cente Reduces traffic on Causeway Street near Arena

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Some air and noise concerns	Incompatible with Arena development and circulation Conflicts with pedestrian circulation on Causeway Street	Substantial impairment to district by affecting traffic flow and access to Causeway/North Washington Streets and Bulfinch Triangle Districts No parkland impacts	
Air quality and noise concerns in Bulfinch Triangle	Incompatible with Arena development and circulation Precludes development of air rights parcel between Causeway and Traverse Streets Serious visual/aesthetic intrusion in Bulfinch Triangle Conflicts with pedestrian circulation on Causeway Street	Continued impairment to both Causeway and North Washington Streets and Bulfinch Triangle Districts by elevated element visually and physically separating them; possible construction period impacts to buildings in both districts No parkland impacts	
Reduced air/noise concerns	Compatible with Arena development Enhances pedestrian environment on Causeway Street	Positive effect of reuniting two districts No parkland impacts	

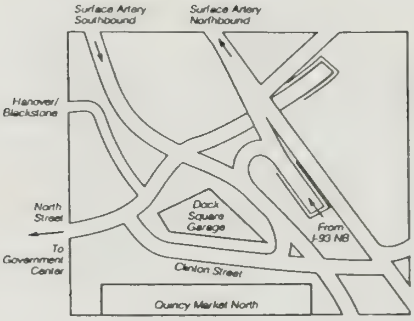
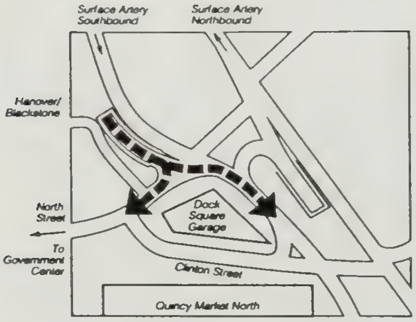
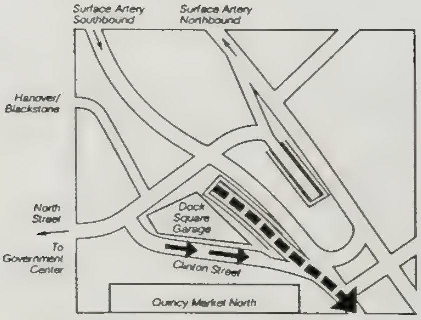
2 • I-93 NORTHBOUND ON-RAMP FROM CAUSEWAY STREET AREA

	Design Options	Traffic and Transportation
 I 93 NB I 93 SB North Washington Street Causeway Street Surface Artery Northbound New Boston Arena Surface Artery Southbound Chardon St. New	**FEIS/R** On-ramp from Causeway Street directly to I-93 northbound	Provides direct connection from Causeway Street to I-93 northbound Creates weave problem I-93 northbound mainli Degrades traffic operations on Causeway Street
 I-93 NB I-93 SB North Washington Street Causeway Street Overpass New Boston Arena Overpass Chardon St. New Surface Artery Northbound Surface Artery Southbound	**Fly-Over Scheme** On-ramp from Traverse Street on elevated viaduct over Causeway Street and on-ramp from Causeway Street	Provides direct connection from Cause Street to I-93 northbound Creates weave problem I-93 northbound mainli
 I-93 NB I-93 SB North Washington Street Causeway Street Underpass New Boston Arena New Chardon Street Surface Artery Northbound Surface Artery Southbound	**Proposed Action** On-ramp from Traverse Street in tunnel under Causeway Street, continues as separate bridge over Charles River	Improves traffic operations on Causewa Street No weaving problem o I-93 northbound

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Local air and noise concerns	Conflicts with pedestrian circulation on Causeway Street	No parkland impacts	Conflicts with existing off-ramp to Storrow Drive and requires removal prior to opening new connector
Local air quality and noise concerns	Precludes development of air rights parcel between Causeway Street and Traverse Street Reduces ability to develop Stop & Shop and Charles River buildings Serious visual/aesthetic intrusion in Bulfinch Triangle Conflicts with pedestrian circulation on Causeway Street	No historic or parkland impacts	Conflicts with existing off-ramp to Storrow Drive and requires removal prior to opening new connector
Reduces noise and air quality impacts at Causeway Street	Enhances pedestrian environment on Causeway Street	No impact on historic Charles River and Stop & Shop buildings No parkland impacts	Enables movement to Storrow Drive to remain in operation throughout construction

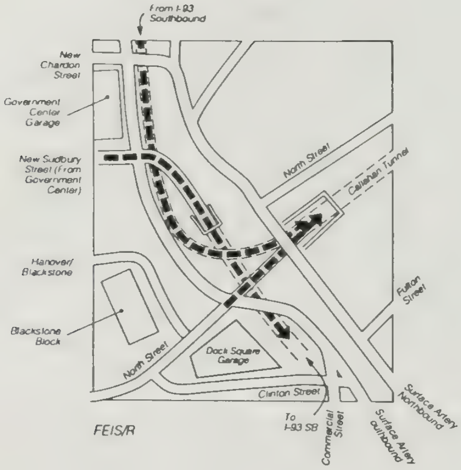
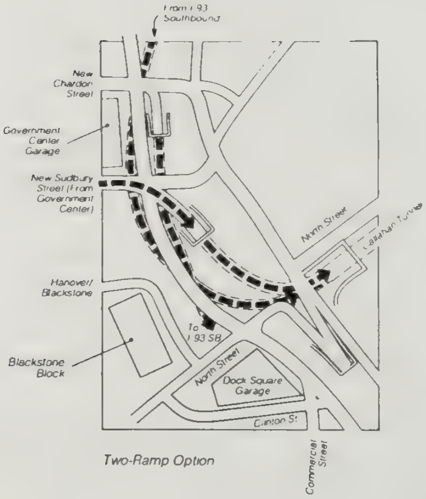
3 • I-93 SOUTHBOUND OFF-RAMP TO GOVERNMENT CENTER AREA

	Design Options	Traffic and Transportation
 Surface Artery Southbound Surface Artery Northbound Hanover/ Blackstone North Street To Government Center Dock Square Garage From I-93 NB Clinton Street Quincy Market North FEIS/R – No Ramp	**FEIS/R** No Ramp No Government Center southbound off-ramp; off-ramp at Causeway Street	Less direct access to Government Center; adds traffic to Causeway Street and southbound Surface Artery Direct access for buses to proposed MBTA bus station and garage on Canal Street
 Surface Artery Southbound Surface Artery Northbound Hanover/ Blackstone North Street To Government Center Dock Square Garage Clinton Street Quincy Market North North Street Ramp	**North Street Ramp** Southbound off-ramp at North Street with access to southbound Surface Artery	Adds traffic to already congested North Street
 Surface Artery Southbound Surface Artery Northbound Hanover/ Blackstone North Street To Government Center Dock Square Garage Clinton Street Quincy Market North Proposed Action – Ramp At Clinton Street	**Proposed Action** Southbound off-ramp at Clinton Street to southbound Surface Artery; Clinton Street reversed to one-way eastbound	Adds traffic at less congested point; no conflict with North Street Less traffic on southbound Surface Artery between Causeway Street and North Street Weave of ramp traffic with surface traffic to State Street No direct access for buses to proposed MBTA bus station and garage on Canal Street

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
	Conflicts with pedestrian circulation on Causeway Street	No historic impacts No parkland impacts	
	Pedestrian connections disruption along North Street Boat section to North Street destroys air rights parcel between Blackstone and southbound Surface Artery	Boat section next to historic Blackstone Block No parkland impacts	
	Requires reconfiguration of garage entrance Limits ramps to one parcel Permits two air rights parcels to reunite North End with Blackstone Block North Street/southbound Surface Artery intersection raised Boat section next to parking garage	No historic impacts No parkland impacts	Ramp possibly requires underpinning at Dock Square parking garage

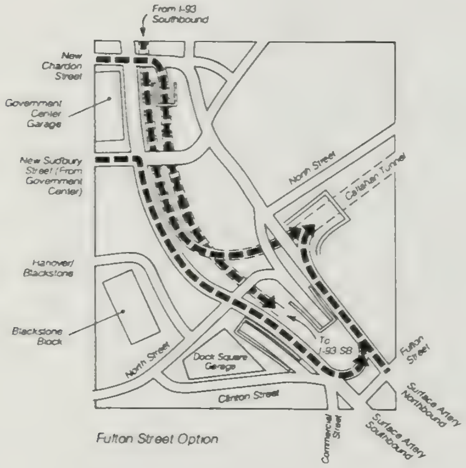
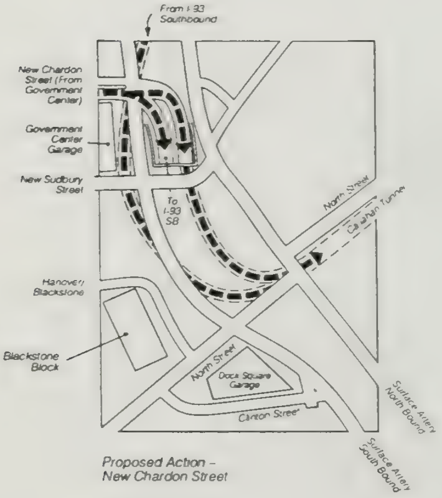
4 • I-93 SOUTHBOUND ON-RAMP FROM GOVERNMENT CENTER AREA AND ON-RAMPS TO CALLAHAN TUNNEL

	Design Options	Traffic and Transportation
 From I-93 Southbound New Chardon Street Government Center Garage New Sudbury Street (From Government Center) Hanover/ Blackstone Blackstone Block North Street Callahan Tunnel Fulton Street North Street Dock Square Garage Clinton Street To I-93 SB Commercial Street Surface Artery southbound Surface Artery Northbound FEIS/R	**FEIS/R** On-ramp to I-93 southbound from New Sudbury Street On-ramp to Callahan Tunnel from North Street and southbound surface artery intersection	On-ramp to Callahan Tunnel adds large volumes to already congested North Street intersection Major profile problems clearing Callahan Tunnel ramp under northbound Surface Artery
 From I-93 Southbound New Chardon Street Government Center Garage New Sudbury Street (From Government Center) Hanover/ Blackstone Blackstone Block North Street Callahan Tunnel To I-93 SB North Street Dock Square Garage Clinton St Commercial Street Two-Ramp Option	**Two Ramp Option** On-ramp to I-93 southbound from New Chardon Street On-ramp to Callahan Tunnel from New Sudbury Street	Callahan Tunnel traffic merges from 3 to 2 to 1 lane in minimum distanc on sharp curve Traffic operations on New Chardon Street congested but adequate Cross road weaves on Sudbury Street to sort Callahan traffic from northbound Surface Artery move

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
	Requires raising northound Surface Artery 10 feet higher than southbound Surface Artery Places four portals between North End and Government Center	No historic or parkland impacts	
Moderate air/noise impacts due to longer trip on surface streets	Two parcels impacted by boat sections Difficult to develop parcels in front of Government Center garage because of ground level accessibility from Sudbury Street Makes physical reconnection of Blackstone Block and North End impossible Disrupts pedestrian and vehicle connections between North End and Government Center/Haymarket/Blackstone areas	Parcel 7 garage entrances/exits from/to Hanover Street could substantially impair Blackstone District	

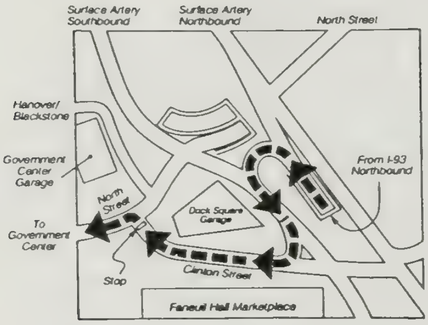
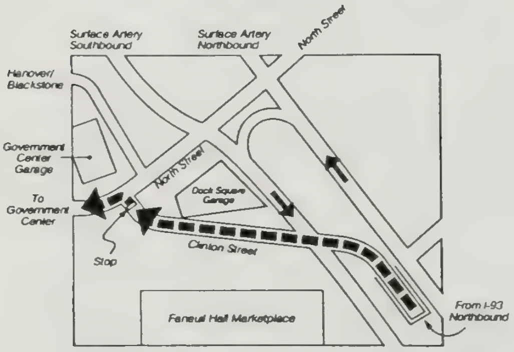
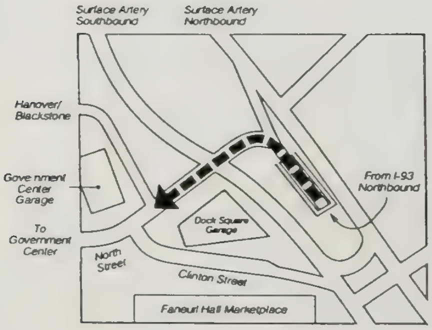
4 • I-93 SOUTHBOUND ON-RAMP FROM GOVERNMENT CENTER AREA AND ON-RAMPS TO CALLAHAN TUNNEL (Cont'd)

	Design Options	Traffic and Transportation
 From I-93 Southbound New Chardon Street Government Center Garage New Sudbury Street (From Government Center) Hanover/ Blackstone Blackstone Block North Street Callahan Tunnel To I-93 SB Dock Square Garage North Street Clinton Street Fulton Street Commercial Street Surface Artery Northbound Surface Artery Southbound Fulton Street Option	**Fulton Street Option to Callahan Tunnel** Ramp from southbound Surface Artery to existing Callahan Tunnel-loop at Fulton Street to northbound surface artery	Forces all Callahan Tunnel traffic through 2-lane section of northbound Surface Artery and southbound traffic through 180° loop
 From I-93 Southbound New Chardon Street (From Government Center) Government Center Garage New Sudbury Street To I-93 SB North Street Callahan Tunnel Hanover/ Blackstone Blackstone Block North Street Dock Square Garage Clinton Street Surface Artery North Bound Surface Artery South Bound Proposed Action – New Chardon Street	**Proposed Action** Single on-ramp to I-93 southbound and Callahan Tunnel from New Chardon Street	Congested but adequate traffic operations on Congress and New Char Streets No merges or weaves required on ramps Move one block north provides safe weaving section on southbound mainline between on-ra and Oliver Street off-ramp further south

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
	Eliminates continuous sidewalk along northbound surface artery between Commercial and North Streets	No historic or parkland impacts	
Least air/noise impacts due to quick entrance to tunnel	Ramps are concentrated in one small parcel instead of throughout large ones All pedestrian connections along Surface Artery possible Allows Hanover Street to be a visual, pedestrian, vehicular corridor	Traffic and ramp furthest away from Blackstone Block/North End reconnection	

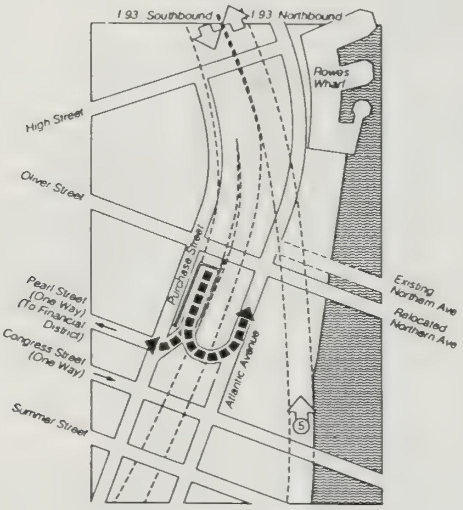
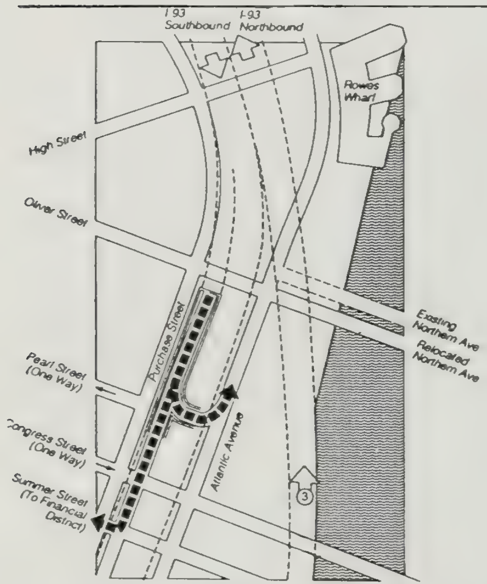
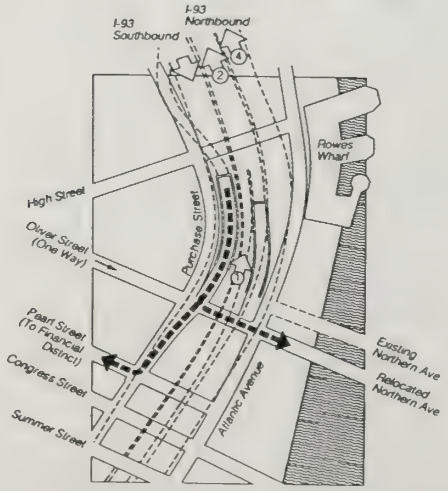
5 • I-93 NORTHBOUND OFF-RAMP TO GOVERNMENT CENTER AREA

	Design Options	Traffic and Transportation
 Surface Artery Southbound Surface Artery Northbound North Street Hanover/ Blackstone Government Center Garage From I-93 Northbound North Street Dock Square Garage To Government Center Stop Clinton Street Faneuil Hall Marketplace FEIS/R	**FEIS/R** Northbound off-ramp at North Station - loops back to southbound Surface Artery Access to Government Center via Clinton and then North Streets	Exit loop-back geometrically impossible because northbound Surface Artery 10 feet above southbound to Callahan Tunnel entranc Circuitous routing with high volume creates traffic congestion Requires use of heavily congested Clinton Street, which conflicts with Faneuil Market deliveries and garage access
 Surface Artery Southbound Surface Artery Northbound North Street Hanover/ Blackstone Government Center Garage North Street Dock Square Garage To Government Center Stop Clinton Street Faneuil Hall Marketplace From I-93 Northbound Clinton Street Off-Ramp	**Clinton Street Off-Ramp** Northbound off-ramp to Clinton Street westbound and then North Street, crossing southbound Surface Artery	Awkward crossing of southbound Surface Artery by off-ramp Conflicts with heavy use of Clinton Street for Faneuil Market deliveries and garage access Allows full roadway at Mercantile Wharf buildings
 Surface Artery Southbound Surface Artery Northbound Hanover/ Blackstone Government Center Garage From I-93 Northbound To Government Center Dock Square Garage North Street Clinton Street Faneuil Hall Marketplace Proposed Action	**Proposed Action** Northbound off-ramp to North Street, westbound on North to Goverment Center Reverse to southbound Surface Artery possible Portal limits northbound Surface Artery to 2 lanes at Mercantile Wharf building	Most direct route to Government Center Clinton Street used primarily for Faneuil Hall Market garage access

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Worst air/noise impacts	Heavy use of Clinton Street and large volumes turning left on North Street degrade pedestrian environment North Street view corridor interrupted by boat sections Pedestrian circulation along southbound Surface Artery disrupted particularily at Clinton Street	No historic or parkland impacts	
Moderate air/noise impacts	Disrupts development parcels with ramp in middle Heavy use of Clinton Street and large volumes turning left on North Street degrade pedestrian environment Open boat section adjacent to Walk-to-the-Sea unsightly and hinders pedestrian connections	No historic or parkland impacts	
Least air/noise impacts	Intersection of North Street/southbound Surface Artery must be raised Government Center traffic on North Street improves pedestrian environment Northbound and southbound off-ramps consolidated in one parcel Better pedestrian crossing	No historic or parkland impacts	

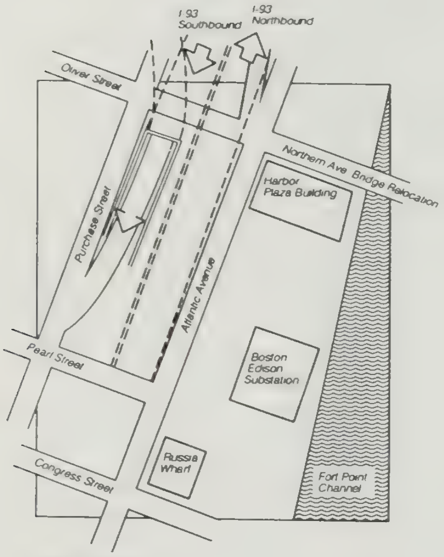
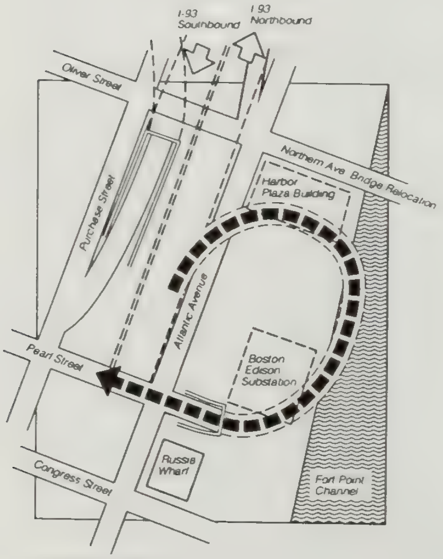
6 • I-93 SOUTHBOUND OFF-RAMP TO FINANCIAL DISTRICT

	Design Options	Traffic and Transportation
 I 93 Southbound I 93 Northbound Rowes Wharf High Street Oliver Street Purchase Street Pearl Street (One Way) (To Financial District) Congress Street (One Way) Summer Street Existing Northern Ave Relocated Northern Ave Atlantic Avenue 5	**FEIS/R** Off-ramp to southbound surface artery at Pearl Street Turn-back loop to Atlantic Avenue northbound and new Northern Avenue bridge	Turn-back loop to Atlantic Avenue at Pear Street not geometrically possible Circuitous route to Northern Avenue Bridg Boat section along Purchase Street blocks vehicular access to joint development parce on Purchase Street
 I 93 Southbound I-93 Northbound Rowes Wharf High Street Oliver Street Existing Northern Ave Relocated Northern Ave Purchase Street Pearl Street (One Way) Congress Street (One Way) Summer Street (To Financial District) Atlantic Avenue 3	**Initial Revision** Off-ramp at Congress Street with traffic routed to Summer Street Turn-back loop at Pearl Street to Atlantic Avenue northbound and new Northern Avenue bridge	Pearl Street cannot connect to Atlantic Avenue Traffic entering Financial District concentrated on Summ Street, causing congestion Circuitous route to Northern Avenue
 I-93 Southbound I-93 Northbound 4 2 1 Rowes Wharf High Street Oliver Street (One Way) Purchase Street Pearl Street (To Financial District) Congress Street Summer Street Existing Northern Ave Relocated Northern Ave Atlantic Avenue	**Proposed Action** Off-ramp past Oliver Street to Pearl Street Left turn to new Northern Avenue	Traffic enters Financia District via Pearl Street. Direct connection between Oliver Street and Northern Avenue to S Boston

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Air/noise impacts similar for all options No water impacts	Joint development over Artery Tunnel difficult for Oliver Street to Pearl Street parcel due to boat section Boat section along Purchase Street blocks pedestrian access	Probable adverse effects on Oliver/Purchase Streets District and Gridley Street District No parkland impacts	Geometric conflicts with gravity sewer relocations
Air/noise impacts similar for all options No water impacts	Extends boat section past Oliver to Pearl and Pearl to Congress air rights parcels. With turn-back loop, limits development on two parcels Negative impact on pedestrian environment along Purchase Street, eliminates through-parcel and Pearl Street pedestrian connection	Adverse effect on Oliver/Purchase Streets District No parkland impacts	Less impact on Purchase Street during construction
Air/noise impacts similar except north of other two options No water impacts	Allows extension of Pearl Street to Atlantic Avenue Limits impacts of ramps to one parcel instead of several Pedestrian crossing difficult on north side of Oilver Street Difficult development of this parcel, High to Oliver, because of two ramps and blocking of pedestrian and vehicular access	No historic or parkland impacts	

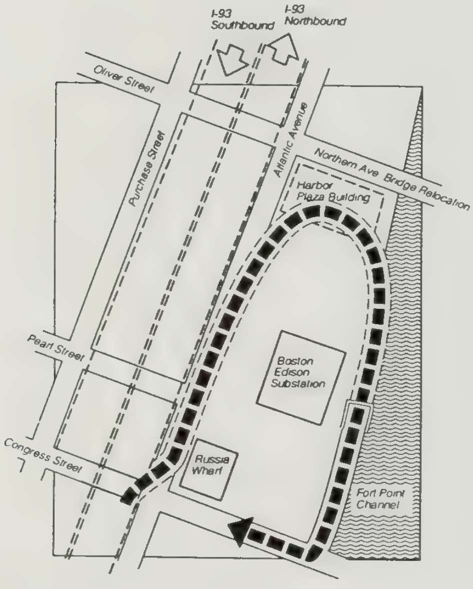
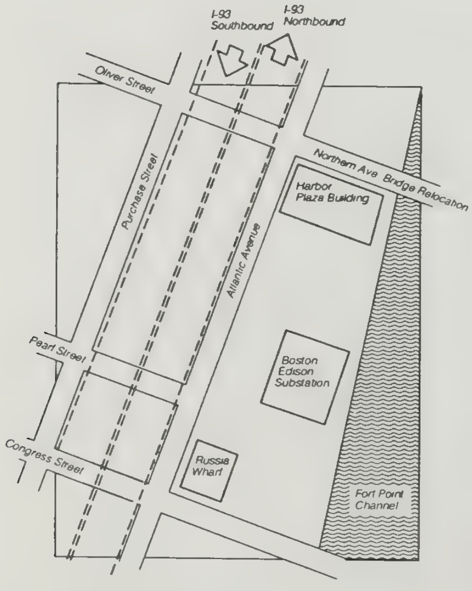
7 • I-93 NORTHBOUND OFF-RAMP TO FINANCIAL DISTRICT

	Design Options	Traffic and Transportation
 FEIS/R – No Ramp	**FEIS/R** No northbound off-ramp between Kneeland and State Streets	NA
 Pearl Street Off-Ramp	**Pearl Street Off-Ramp** Northbound mainline off-ramp through Boston Edison parcel to Pearl Street	Provides most direct northbound off service to Financial District Low forecasted volumes Safety concerns in northbound tunnel, in boat section and on surface streets

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
NA	NA	NA	NA
Tunnel in Fort Point Channel causes water impacts Air/noise impacts minimal	Takes Harbor Plaza with 1,000 jobs Boston Edison substation affected; requires major utility relocation Creation of larger parcel by taking of Harbor Plaza allows for greater integration of ventilation building into complex Pedestrian connections along Atlantic Avenue disrupted	Substantial impact to historic Fort Point Channel Requires underpinning of historic Russia Wharf on west end and creates barrier on east end	Difficult construction in Fort Point Channel Additional major tunnel construction required

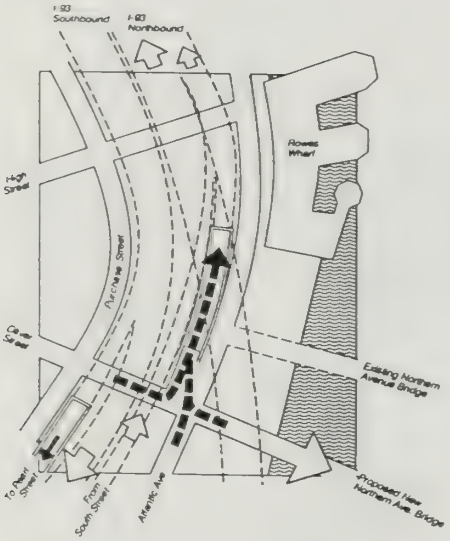
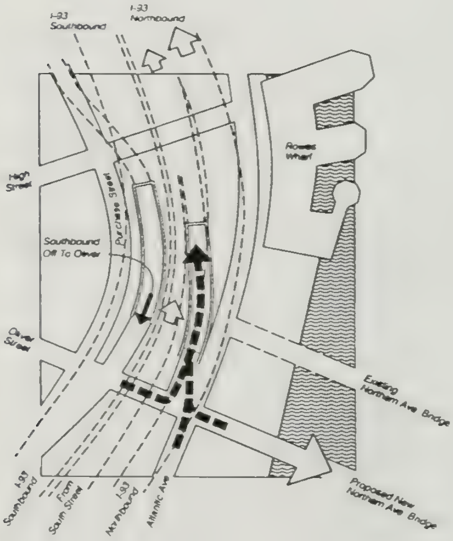
7 • I-93 NORTHBOUND OFF-RAMP TO FINANCIAL DISTRICT (Cont'd)

	Design Options	Traffic and Transportation
 I-93 Southbound I-93 Northbound Oliver Street Purchase Street Atlantic Avenue Northern Ave Bridge Relocation Harbor Plaza Building Boston Edison Substation Pearl Street Congress Street Russia Wharf Fort Point Channel Congress Street Off-Ramp	**Congress Street Off-Ramp** Northbound mainline off-ramp through Boston Edison parcel, along Fort Point Channel to Congress Street	Provides northbound service to Financial District Low forecasted volum Safety concerns in northbound tunnel an boat section Traffic enters onto already congested Congress Street
 I-93 Southbound I-93 Northbound Oliver Street Purchase Street Atlantic Avenue Northern Ave Bridge Relocation Harbor Plaza Building Boston Edison Substation Pearl Street Congress Street Russia Wharf Fort Point Channel Proposed Action – No Ramp	**Proposed Action** No off-ramp	Three other routes to Financial District: 1) Lincoln-High-Fed Streets 2) Atlantic Avenue- Street 3) Seaport Access R to both Congress Street and North Avenue

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Tunnel box in Fort Point Channel causes water impacts Air/noise impacts minimal	Takes Harbor Plaza with 1,000 jobs Boston Edison substation not affected Forces splitting of ventilation building with greater impacts to local real estate Blocks access to Fort Point Channel and interrupts Harborwalk path Wall built in channel for construction unsightly and blocks views Forces proposed MBTA Transitway to become boat section which will block Harborwalk path and be visual distraction	Impacts Fort Point Channel, historic resource on the National Register Requires underpinning of historic Russia Wharf on west end and creates barrier on east end	Difficult construction in Fort Point Channel Takes Harbor Plaza building and demolishes it Avoids Boston Edison Edison substation Major additional tunnel construction required
No tunnel box in Fort Point Channel and no water impacts Air/noise impacts minimal	Does not require taking of Harbor Plaza or Boston Edison Buildings No urban design impacts	No impacts to Fort Point Channel or Russia Wharf	No construction required

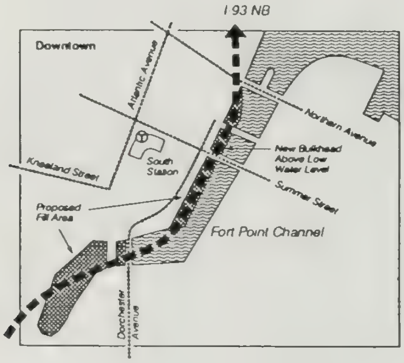
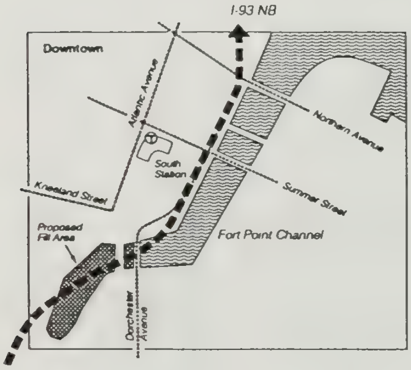
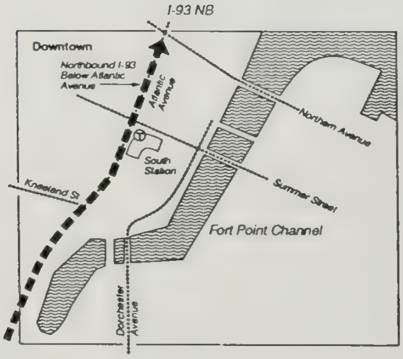
8 • I-93 NORTHBOUND ON-RAMP FROM NORTHERN AVENUE

	Design Options	Traffic and Transportation
	**FEIS/R** "Right-Hand-On" Concept Northern Avenue northbound on-ramp enters mainline on right after joining with South Street on-ramp, both in boat section	Two boat sections redu Atlantic Avenue to thr lanes in front of Rowes Wharf and water taxi/ferry entrance
	**Proposed Action** "Left-Hand-On" Concept Northern Avenue northbound joins South Street on-ramp in tunnel, then joins northbound mainline on the left with an added lane	Allows three moving lanes plus one pick-up drop-off lane in front of Rowes Wharf and v taxi/ferry stop Forces heavy truck movement onto left si of highway

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
No water impacts Air/noise impacts same for all options	Eliminates parking lane required for the hotel and water taxi/ferry stops at Rowes Wharf Traffic congestion interferes with water taxi/ ferry stop and Rowes Wharf Double ramp boat section problem precludes development of air rights parcel between Atlantic and Purchase Streets Disrupts more of pedestrian edge along Atlantic Avenue in front of Rowes Wharf Takes corner of Harbor Towers garage	No historic or parkland impacts	Forces alignment into existing retained fill embankment for I-93 northbound requiring a temporary mainline ramp
No water impacts Air/noise impacts same for all options	Four lanes reduces congestion for water taxi/ferry stop and Rowes Wharf, allows drop-off, pick-up lane Single ramp allows possibility of development of air rights parcel although difficult with southbound off-ramp Pedestrian access along Atlantic Avenue improved with single ramp, four lanes Does not take corner at Harbor Towers Garage	No historic or parkland impacts	Allows proposed northbound to be constructed outside of existing retained fill embankment for I-93 northbound No temporary structures required to maintain traffic

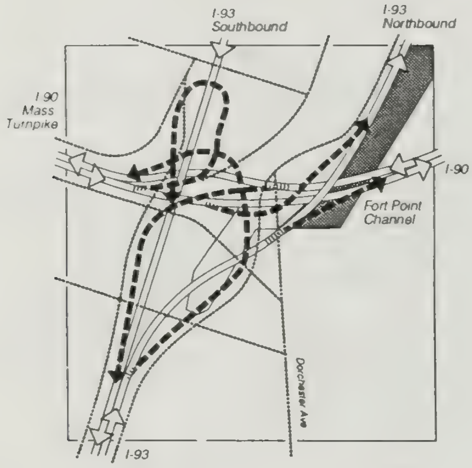
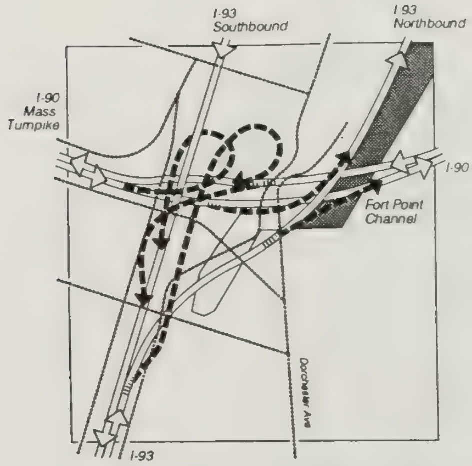
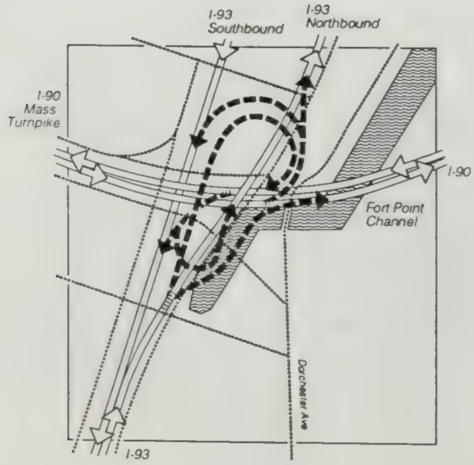
9 • I-93 NORTHBOUND ALIGNMENT - SOUTH STATION AREA

	Design Options	Traffic and Transportation
 I-93 NB Downtown Atlantic Avenue Northern Avenue New Bulkhead Above Low Water Level South Station Kneeland Street Summer Street Proposed Fill Area Fort Point Channel Dorchester Avenue	**FEIS/R** I-93 northbound diverges from I-93 southbound at West Fourth Street bridge, in tunnel under Fort Point Channel, goes underneath Harbor Plaza Building, rejoins I-93 southbound near Northern Avenue Includes new 2-lane northbound surface road over tunnel box on a relocated and extend Dorchester Avenue Fills Fort Point Channel from Dorchester Avenue Bridge south	Surface road allows so traffic to bypass Dewey Square but adds to traffic at Summer/Dorchester intersection
 I-93 NB Downtown Atlantic Avenue Northern Avenue South Station Kneeland Street Summer Street Proposed Fill Area Fort Point Channel Dorchester Avenue	**Dorchester Avenue Alignment** Same as above except located underneath Dorchester Avenue	Surface road allows so traffic to bypass Dewey Square but adds to traffic at Summer/Dorchester intersection
 I-93 NB Downtown Northbound I-93 Below Atlantic Avenue Atlantic Avenue Northern Avenue South Station Kneeland St Summer Street Fort Point Channel Dorchester Avenue	**Proposed Action** I-93 northbound in tunnel under Atlantic Avenue from Kneeland Street to Northern Avenue Passes beneath MBTA Red Line Tunnel at Summer Street Minor fill in Upper Fort Point Channel for I-93/I-90 Interchange bulkhead	Tunnel geometry requi reduced speed at South Station

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Requires largest amount of filling of Upper Fort Point Channel for tunnel box along westerly wall of lower channel	Requires underpinning or taking of Harbor Plaza Building Rising northbound tunnel box along westerly Fort Point Channel wall unsightly Surface Road creates barrier to pedestrian access to Fort Point Channel Some interference with U.S. Postal Service Annex operations during construction	Requires relocation and reconstruction of historic westerly granite wall of Fort Point Channel Permanent impairment to channel by narrowing width and decking Dorchester Avenue in Channel Requires reconstruction of historic Summer and Congress bridges No parkland impacts	Requires extension of Roxbury conduit Requires difficult construction in Fort Point Channel and over the Red Line tunnel in the Channel
Requires less filling than FEIS/R design in Fort Point Channel Water edge impacts along Postal Annex and Russia Wharf	Requires underpinning or taking of Harbor Plaza Major interference with U.S. Postal Service Annex operations during construction	Requires removal and reconstruction of historic granite wall Requires reconstruction of historic Summer and Congress Street bridges No parkland impacts	Requires extension of Roxbury conduit Requires difficult construction in Fort Point Channel and over the Red Line tunnel in the Channel
Requires least amount of filling in Fort Point Channel Least water impacts No air and noise impacts near sensitive receptors since alignment in tunnel	Takes corner of Federal Reserve Bank basement No impact to Harbor Plaza Building Does not interfere with Postal Service Annex operations	Eliminates disruption of historic granite wall Potential construction impacts to Leather District historic structures on Atlantic Avenue, South Station headhouse, and Russia Wharf No parkland impacts	Eliminates construction in Fort Point Channel Temporary disruption of traffic on Atlantic Avenue and in Dewey Square during construction Some temporary impacts to South Station and Red Line Station during construction

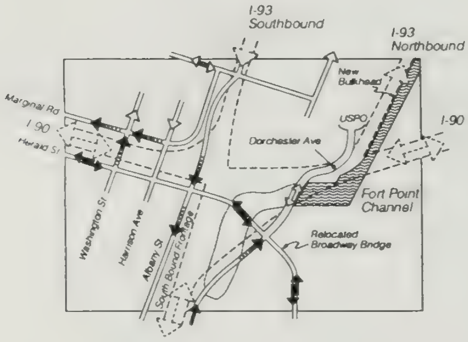
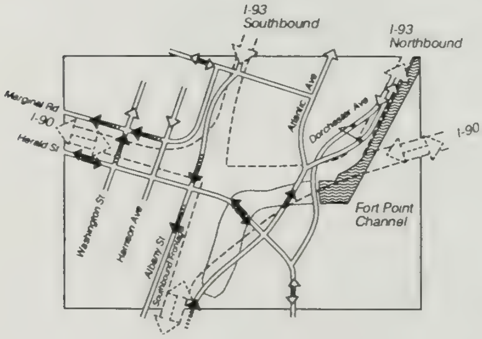
10 • I-93/I-90 INTERCHANGE MAJOR CONNECTORS

	Design Options	Traffic and Transportation
 I-93 Southbound I-93 Northbound I-90 Mass Turnpike I-90 Fort Point Channel Dorchester Ave I-93	**FEIS/R** Major direct move from I-93 northbound to I-90 westbound Northbound mainline in Fort Point Channel	Major weaving problems on ramps and mainlines Less desirable roadway geometry
 I-93 Southbound I-93 Northbound I-90 Mass Turnpike I-90 Fort Point Channel Dorchester Ave I-93	**Intitial Revision** Move from I-93 northbound to I-90 westbound in quarter cloverleaf Northbound mainline in Fort Point Channel	Eliminates most weave problems on ramps, mainlines Better geometry than FEIS/R
 I-93 Southbound I-93 Northbound I-90 Mass Turnpike I-90 Fort Point Channel Dorchester Ave I-93	**Proposed Action** Multiple major ramps nested in common loop configuration Northbound mainline under Atlantic Avenue	Eliminates I-90 weave problems and most othe weave problems Most desirable roadway geometry

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Requires total filling in upper Fort Point Channel from West Fourth Street to Dorchester Avenue Most water impacts Moderate air/noise impacts	Design makes most interchange areas useless for development/open space Interchange closest to Chinatown	Design required substantial impacts to historic Fort Point Channel Impact on Pagoda Park	Substantial construction impacts to Fort Point Channel
Requires total filling in upper Fort Point Channel Major water impacts Moderate air/noise impacts	Design makes most interchange areas useless for development/open space	Substantial impacts to historic Fort Point Channel No impact on Pagoda Park	Substantial construction impacts to Fort Point Channel
Substantially less fill in Fort Point Channel Least water impacts Moderate air/noise impacts	Nested ramps permit development of land inside and adjacent to ramps Permits existing city street grid to extend into interchange area	Modest impacts to historic Fort Point Channel Allows expansion of Pagoda Park	Modest construction impacts to Fort Point Channel

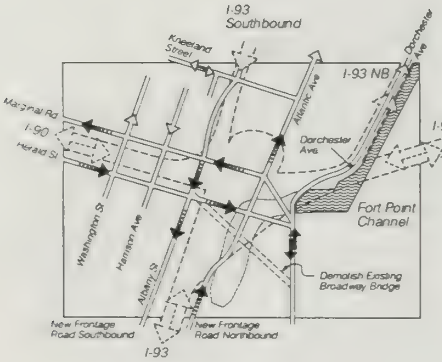
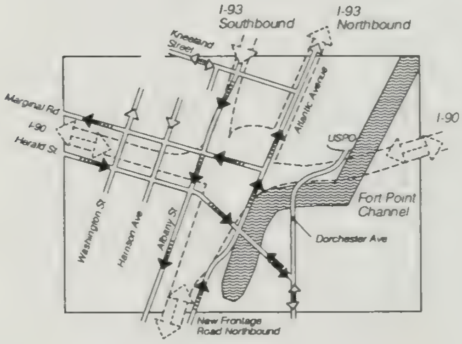
11 • LOCAL STREET RECONSTRUCTION IN I-93/I-90 INTERCHANGE

	Design Options	Traffic and Transportation
 I-93 Southbound I-93 Northbound New Bulkhead USPO I-90 Marginal Rd I-90 Herald St Dorchester Ave Fort Point Channel Relocated Broadway Bridge Washington St Harrison Ave Albany St South Bound Frontage	**FEIS/R** Broadway Bridge rebuilt on new alignment Dorchester Avenue realigned to serve as northbound Frontage Road in Fort Point Channel over tunnel box I-93 northbound move to west on two-way Broadway, to two-way Herald, to Washington Street to Marginal Road	Two-way Herald Str creates intersection capacity problems at Broadway and Front Road northbound, a Broadway/Herald St and Albany Street
 I-93 Southbound I-93 Northbound Marginal Rd I-90 Herald St Atlantic Ave Dorchester Ave I-90 Fort Point Channel Washington St Harrison Ave Albany St Southbound Frontage	**Initial Revision** Broadway Bridge rebuilt on new alignment Northbound Frontage Road connects to both Atlantic Avenue and new two-way Dorchester Avenue over I-93 tunnel in Fort Point Channel	Two-way Herald Stre creates intersection capacity problems as above

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Requires filling of Upper Fort Point Channel Less air/noise impacts on Chinatown	Loss of Broadway Bridge severs important pedestrian connection	Historic Broadway Bridge demolished No parkland impacts	Difficulty maintaining access for Postal Service Annex during construction Potential impacts on MBTA Cabot Yard during new Broadway Bridge construction Requires extension of Roxbury CSO
Requires filling of Upper Fort Point Channel Air/noise impacts on Chinatown along Marginal Road	Loss of Broadway Bridge severs important pedestrian connection Northbound Frontage Road extension to Atlantic Avenue provides good edge to major parcel Forces Dorchester Avenue to 30-foot elevation in front of Gillette headquarters	Historic Broadway Bridge demolished No parkland impacts	Difficulty maintaining access for Postal Service Annex during construction Potential impacts on MBTA Cabot Yard during new Broadway Bridge construction Requires extension of Roxbury CSO

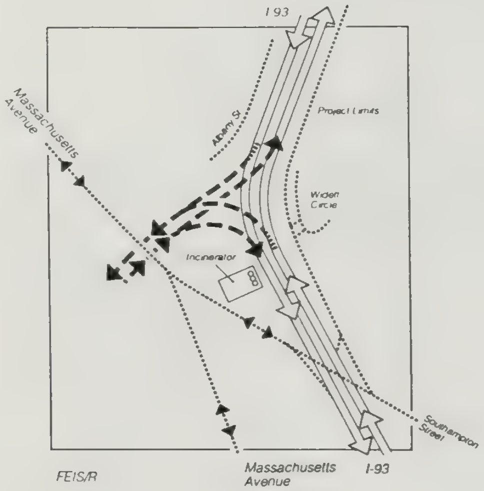
11 • LOCAL STREET RECONSTRUCTION IN I-93/I-90 INTERCHANGE (Cont'd)

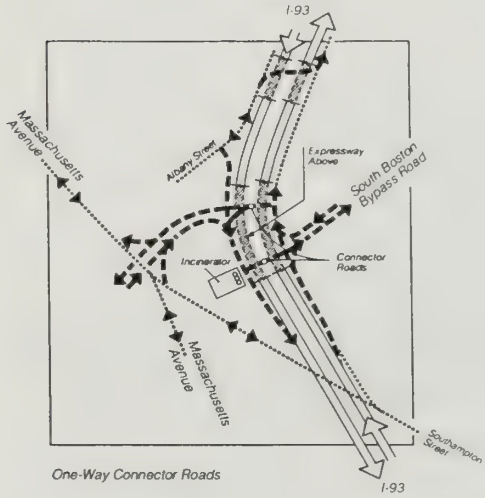
	Design Options	Traffic and Transportation
	**Herald Street/Marginal Road Extended to Dorchester Avenue** Herald Street extended to Dorchester Avenue as one-way eastbound; Marginal Road extended as one-way westbound; Dorchester Avenue on viaduct Frontage Road northbound meets Atlantic Avenue only Broadway Bridge demolished	Creation of one-way couplet reduces key intersection traffic problems on Herald Street Higher levels of traffic introduced on Margin Road by Chinatown
	**Proposed Action** Herald Street and Marginal Road extended as one-way couplet under I-93 southbound viaduct to northbound Frontage Road Frontage Road northbound meets Atlantic Avenue Existing Broadway Bridge modified	Higher levels of traffic introduced on Margina Road by Chinatown Reduces intersection traffic capacity problems on Herald Street

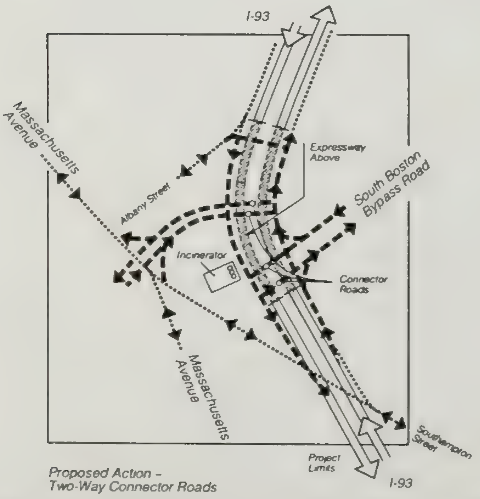
Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Requires filling of Upper Fort Point Channel Air/noise impacts on Chinatown at Marginal Road	Loss of Broadway Bridge severs important pedestrian connection	Historic Broadway Bridge demolished No parkland impacts	Difficulty maintaining access for Postal Service Annex during construction Potential impacts on MBTA Cabot Yard during new Broadway Bridge construction Requires extension of Roxbury CSO
No filling of Upper Fort Point Channel Air/noise impacts on Chinatown at Marginal Road	Northbound Frontage Road extension to Atlantic Avenue provides good eastern edge to major parcel Traffic on Marginal Road impacts residential/institutional edge of Chinatown Preserves important direct pedestrian connection on Broadway Bridge	Historic Broadway Bridge preserved in place No parkland impacts	Eliminates impacts to Postal Service Annex on Dorchester Avenue Reduces amount of construction required in Fort Point Channel Reduces required bridge demolitions in Fort Point Channel No anticipated impacts to MBTA Cabot Yard

12 • MASSACHUSETTS AVENUE INTERCHANGE AREA

<table>
<tr><th></th><th>Design Options</th><th>Traffic and Transportation</th></tr>
<tr><td>

FEIS/R</td>
<td>FEIS/R
Massachusetts Avenue connectors unchanged
No South Boston Bypass Road proposed
Project limit north of Massachusetts Avenue
Improvements to Massachusetts Avenue Interchange and HOV ramps to be done by others</td>
<td>High speed left-hand northbound on-ramp to Expressway required continued closure of West Fourth Street off-ramp for safety, preventing connection to northbound Frontage Roa
High speed left-hand northbound off-ramp to Massachusetts Avenue undesirable
No continuous southboun Frontage Road south of Albany Street</td></tr>
<tr><td>

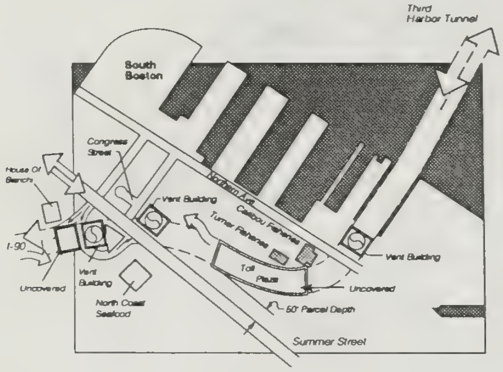
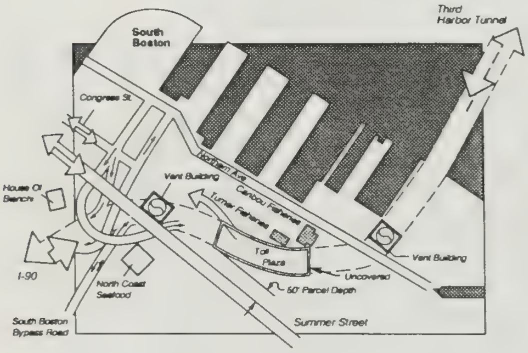
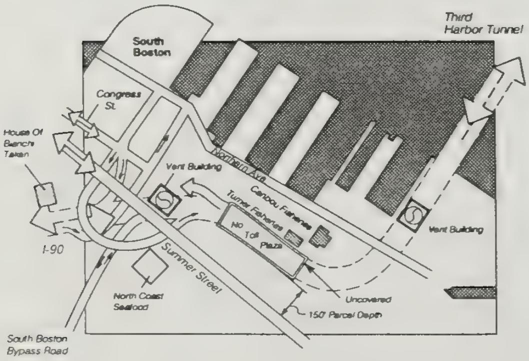
One-Way Connector Roads</td>
<td>One-Way Connector Roads
Two one-way connector roads built between the northbound and southbound service roads.
Southbound Frontage Road discontinuous, uses portion of Albany Street
South Boston Bypass Road proposed
Project limit located between Boston and Southamption Streets</td>
<td>Eliminates high speed left-hand northbound off-ramp
One-way connectors create rotary situation increasing traffic conflicts and making connections to South Boston Bypass Road more circuitous
Provides continuous southbound Frontage Road from Central Area to Southampton Street
Weave problems between Frontage southbound on-ramp and Boston Street off-ramp
Provides for HOV connections</td></tr>
<tr><td>

Proposed Action - Two-Way Connector Roads</td>
<td>Proposed Action - Two-Way Connector Roads
Two two-way connector roads built between the northbound and southbound service roads. One pair aligned with Massachusetts Avenue, one pair aligned with the South Boston Bypass Road
Continuous northbound and southbound Frontage Roads
Project limits located between Southampton and Boston Streets</td>
<td>Two two-way connectors create best traffic flow and provide best connection to Frontage Road, HOV system, and South Boston Bypass Road
Eliminates left-hand northbound off-ramp
Eliminates weave problem between Frontage Road on- and Boston Street off-ramps
Improved HOV connections and system</td></tr>
</table>

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Least air/noise impacts No water impacts	Possible partial impact to Castle Metal Building	N/A	
Moderate air/noise impacts No water impacts Possible contaminated soil disposal required from nearby automobile graveyard site and substation site	Possible partial impact to Castle Metal Building More usable land provided in the existing inaccessible infield area Permanent loss of 300 publicly owned parking spaces in hospital area Impact to Waldo railroad freight spur	N/A	
Moderate air/noise impacts No water impacts Possible contaminated soil disposal required from nearby automobile graveyard site and substation site	Requires taking of Boston Tire Company and Boston Edison Substation #323 May require partial or total taking of Castle Metal Company Loss of some jobs Permanent loss of 330 publicly owned parking spaces in hospital area Impacts to Waldo railroad freight spur	N/A	

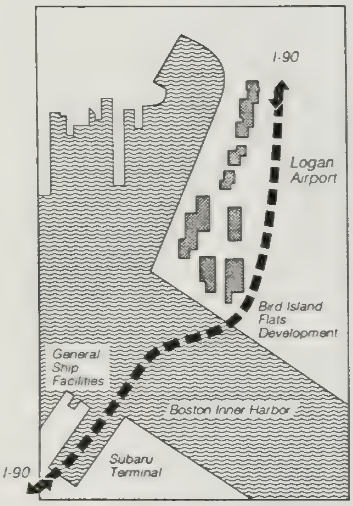
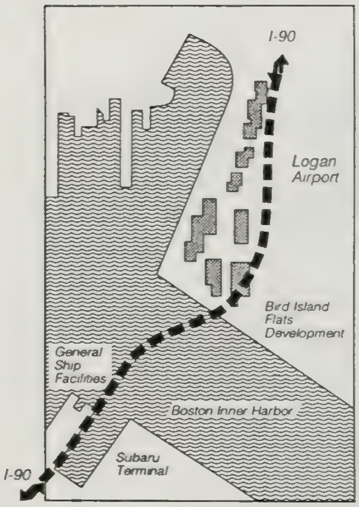
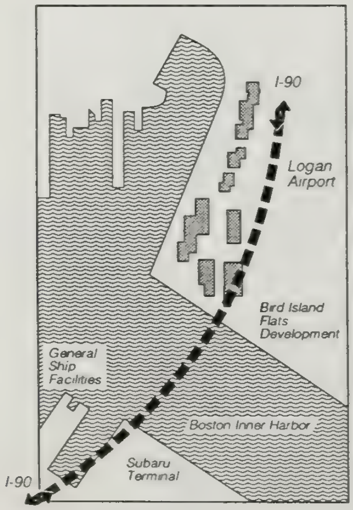
13 • I-90 MAINLINE ALIGNMENT - SOUTH BOSTON

	Design Options	Traffic and Transportation
 Third Harbor Tunnel South Boston Congress Street House Of Bianchi I-90 Uncovered Vent Building North Coast Seafood Northern Ave. Caribou Fisheries Turner Fisheries Toll Plaza Vent Building Uncovered 50' Parcel Depth Summer Street	**FEIS/R** Partially covered/uncovered mainline One on- and off-ramp both eastbound and westbound to/from Summer and Congress Streets Toll Plaza No South Boston Bypass Road No HOV system	Minimum on- and off-ramps creates limited access to local streets No weave problems on mainline Toll plaza creates potential queuing back into Third Harbor Tunnel
 Third Harbor Tunnel South Boston Congress St. House Of Bianchi I-90 South Boston Bypass Road Vent Building Northern Ave. Caribou Fisheries Turner Fisheries Toll Plaza North Coast Seafood Vent Building Uncovered 50' Parcel Depth Summer Street	**Initial Revision** Mostly covered mainline Numerous on- and off-ramps both eastbound and westbound to local streets Toll Plaza South Boston Bypass Road incorporated HOV system added	Numerous on- and off-ramps create good access to local streets Weave problems on mainline Toll plaza creates potential queuing back into Third Harbor Tunnel
 Third Harbor Tunnel South Boston Congress St. House Of Bianchi Taken I-90 South Boston Bypass Road Vent Building Northern Ave. Caribou Fisheries Turner Fisheries No Toll Plaza Summer Street North Coast Seafood Vent Building Uncovered 150' Parcel Depth	**Proposed Action** Collector-Distributor roadway system added on either side of mainline Mostly covered mainline On- and off-ramps to local streets shifted onto collector-distributor roadways Toll plaza moved to Logan Airport South Boston Bypass Road incorporated HOV system incorporated	No weave problems on mainline Most number of on and off connections to local streets (on collector-distributor roadway) More weaves on ramps Toll plaza moved to Logan Airport eliminates queuing problems in Third Harbor Tunnel HOV system operations improved

Source: B/PB and MDPW

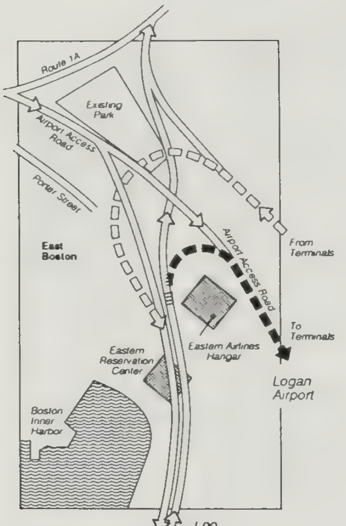
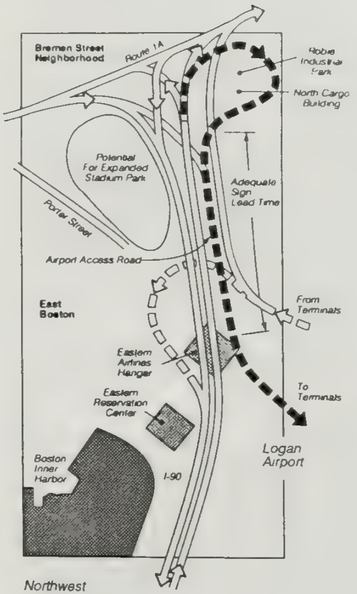
Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Three ventilation buildings Air and noise impacts at toll plaza	Avoids House of Bianchi Avoids North Coast Seafoods Alignment permits creation of larger parcels along Summer Street	No parkland impacts	Easiest construction
Two ventilation buildings required Air and noise impacts at toll plaza	Avoids House of Bianchi Takes corner of North Coast Seafoods building Northern shift of alignment allows larger development parcels between Summer Street and Massport Haul Road	No parkland impacts	Difficult construction
Two ventilation buildings required	Takes House of Bianchi Takes corner of North Coast Seafoods building Northern shift of alignment allows larger development parcels between Summer Street and Massport Haul Road	No parkland impacts	Most difficult construction

14 • THIRD HARBOR TUNNEL ALIGNMENT - SOUTH BOSTON

	Design Options	Traffic and Transportation
 I-90 Logan Airport Bird Island Flats Development General Ship Facilities Boston Inner Harbor Subaru Terminal I-90	**FEIS/R** Tunnel through slip between General Ship pier and Subaru Terminal	Reverse curve Sight shelves required in South and East Boston making alignment wider and more costly Alignment geometry undesirable
 I-90 Logan Airport Bird Island Flats Development General Ship Facilities Boston Inner Harbor Subaru Terminal I-90	**Initial Revision** The City of Boston Concept Tunnel passes through General Ship facilities	Worse reverse curve Sight shelf required in South Boston, making alignment wider and more costly Alignment geometry undesirable
 I-90 Logan Airport Bird Island Flats Development General Ship Facilities Boston Inner Harbor Subaru Terminal I-90	**Proposed Action** Tunnel passes through Subaru Terminal	Reverse curve eliminated Very smooth curves - no sight shelves required Best highway alignment

Source: B/PB and MDPW

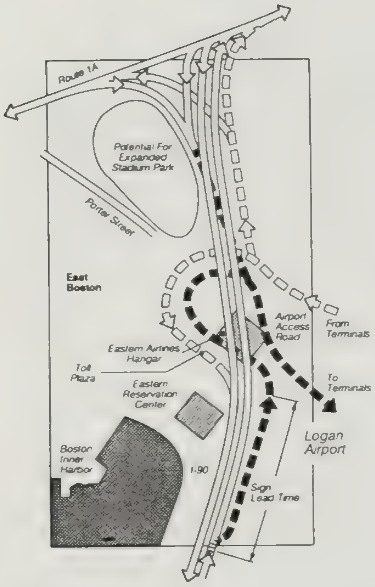
Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Blasting adjacent to General Ship facilities, 150 feet away Major filling in slip		No historic or parkland impacts	Increased construction difficulty due to varying tube dimensions Greatest construction cost due to sight shelves
Blasting adjacent to General Ship faciliites, 150 feet away Major filling in slip	Requires taking of General Ship with potential loss of 400 jobs	No historic or parkland impacts	Increased construction difficulty due to varying tube dimensions
Blasting operations further away from General Ship facilities, 350 to 550 feet away Additional excavation required since alignment passes through Subaru Terminal Least filling in slip		No historic or parkland impacts	Easy to construct due to standardized tube dimensions Temporary construction impacts to Subaru operations

	Design Options	Traffic and Transportation
 Route 1A Existing Park Airport Access Road Porter Street East Boston Airport Access Road From Terminals To Terminals Eastern Airlines Hangar Eastern Reservation Center Logan Airport Boston Inner Harbor I-90 FEIS/R	**FEIS/R** No modification to existing airport access and egress roadways Arrivals and departures not separated and existing ramps unchanged I-90 connects to Route 1A	Inadequate sign distances to airport Direct ramps to airport terminals Roadway geometry requires reduced speeds for airport-bound traffic
 Bremen Street Neighborhood Route 1A Robie Industrial Park North Cargo Building Potential For Expanded Stadium Park Adequate Sign Lead Time Porter Street Airport Access Road East Boston From Terminals Eastern Airlines Hanger To Terminals Eastern Reservation Center Logan Airport Boston Inner Harbor I-90 Northwest Alignment	**Northwest Alignment** Airport-bound traffic from Third Harbor tunnel directed to vicinity of Route 1A and reversed through Robie Industrial Park back to airport terminals I-90 connects directly to Route 1A	Adequate sign distances provided but excessive travel time required for airport- bound traffic from I-90 Design speeds reduced on loop-back for airport-bound traffic from I-90

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Minimum air/noise impacts		Minimal long term impacts to Stadium Park	Construction impacts to southeastern edge of East Boston Memorial Stadium Park
More noise and air quality impacts since much of roadway is on structure over Robie Industrial Park near Route 1A, Bremen Street neighborhood	Disrupts Robie Air Park and North Cargo building Visual impact of major viaduct structure on Bremen Street neighborhood	No parkland impacts	No construction impacts to park

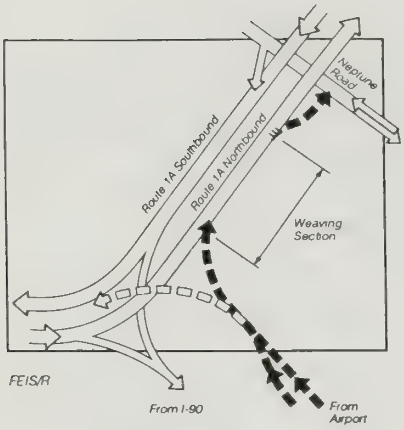
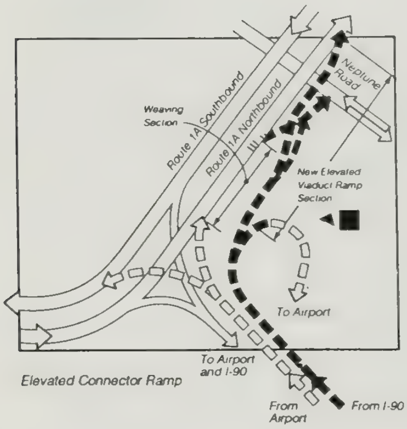
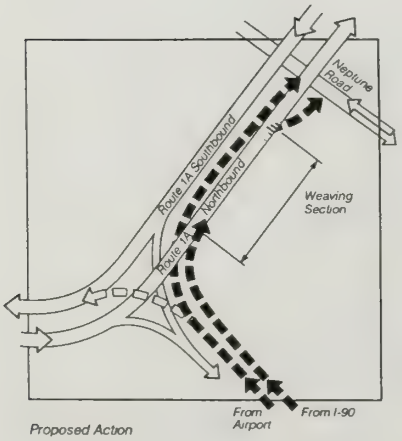
15 • LOGAN AIRPORT INTERCHANGE - EAST BOSTON (Cont'd)

	Design Options	Traffic and Transportation
 Route 1A Potential For Expanded Stadium Park Porter Street East Boston Airport Access Road From Terminals Eastern Airlines Hangar Toll Plaza To Terminals Eastern Reservation Center Logan Airport Boston Inner Harbor I-90 Sign Lead Time	**Proposed Action** Airport-bound traffic from Third Harbor Tunnel directed through separate tunnel in Bird Island Flats area to southwest location swings in loop back to airport, joining traffic from Route 1A I-90 connects directly to Route 1A Toll plazas for exiting airport traffic and Route 1A traffic to the Third Harbor Tunnel included	Direct ramps to airport terminals Adequate sign distance and reduced travel time provided via separate airport-bound roadway Roadway geometry requires reduced design speeds for airport bound from I-90; not as severe as Northwest Alignment option, however Permits HOV priority into Third Harbor Tunne Toll collection at Logan Airport allows for metering of traffic into Third Harbor Tunnel, for traffic control and safety

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Least air/noise impacts since mostly tunnel Moderate noise impact on East Boston Memorial Stadium Park	Most takings and land use impacts on Massport property	Beneficial long term impacts to Stadium Park Allows future expansion of park by removing inbound ramps, allowing direct access to Porter Street area	Construction impacts to park when ramps removed and boat section built

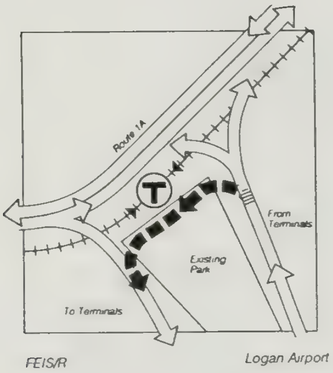
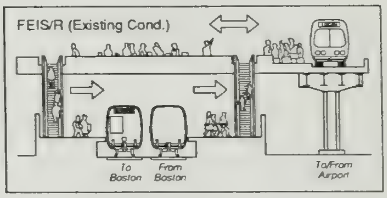
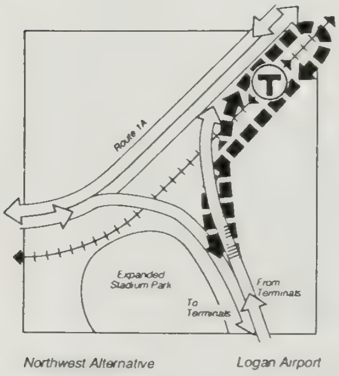
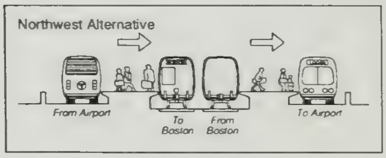
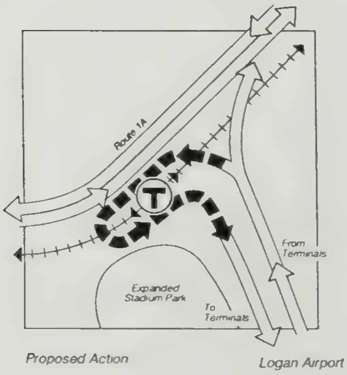
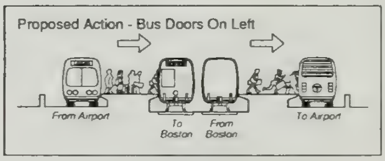
16 • CONNECTIONS TO ROUTE 1A NORTHBOUND - EAST BOSTON

	Design Options	Traffic and Transportation
 Neptune Road Route 1A Southbound Route 1A Northbound Weaving Section From I-90 From Airport FEIS/R	**FEIS/R** I-90 eastbound, westbound and airport connectors to Route 1A are elevated ramps in similar location as existing ramps	I-90 eastbound and airport egress traffic must weave with northbound Route 1A traffic to exit onto Neptune Road - poor weave condition Peak period congestion on both sides of Route 1A between Neptune Road and connectors
 Neptune Road Weaving Section Route 1A Southbound Route 1A Northbound New Elevated Viaduct Ramp Section To Airport To Airport and I-90 From Airport From I-90 Elevated Connector Ramp	**Elevated Connector Ramp** I-90 eastbound, westbound and airport connectors are elevated ramps Elevated ramp from I-90 and the airport to Route 1A northbound grade - separated from Neptune Road	Separate exit from I-90 eastbound to Neptune Road Airport egress merges with Route 1A and weaves for exit to Neptune Road Reduces weaving on Route 1A northbound
 Neptune Road Route 1A Southbound Route 1A Northbound Weaving Section From Airport From I-90 Proposed Action	**Proposed Action** Fly-Under Concept Connecting ramps to Route 1A are primarily depressed or underground Only I-90 eastbound and Route 1A can exit at Neptune Road Airport egress traffic reaches Neptune Road via the Airport Service Road	Airport egress traffic reaches Neptune Road via the Airport Service Road; no exit from Airport egress to Neptune Road I-90 eastbound merges with Route 1A northbound and weaves for exit to Neptune Road Weaving on Route 1A northbound reduced

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Some air and noise impacts since connections are elevated	Least land use impact	N/A	
Some air and noise impacts since connections are elevated	Greatest property impact along Route 1A due to alignment north of Neptune Road	N/A	
Fewer air and noise impacts since some sections are elevated	Less property impacts required than Elevated Connector Ramp Option but slightly more than FEIS/R Best urban design layout since ramps primarily underground and less complex	N/A	

17 • CONNECTIONS TO MBTA BLUE LINE AIRPORT STATION - EAST BOSTON

	Design Options	Traffic and Transportation
 Route 1A From Terminals Existing Park To Terminals FEIS/R Logan Airport	**FEIS/R** Uses existing ramps of elevated roadway to deliver patrons to upper level of airport station  FEIS/R (Existing Cond.) To Boston From Boston To/From Airport	Patrons must go up and down stairs/escalators with luggage to waiting bus Does not provide for future people mover connection except existing bus service
 Route 1A Expanded Stadium Park To Terminals From Terminals Northwest Alternative Logan Airport	**Northwest Alternative** Airport station relocation approximately 800 feet north with at-grade connections to Blue Line station platform Assumes new interchange in northwest quadrant  Northwest Alternative From Airport To Boston From Boston To Airport	Service to/from station better but relocation of station inconvenient to patrons south of Porter Street Provides better interface with airport terminals, but does not serve patrons well Patrons cross platform from Blue Line to bus
 Route 1A Expanded Stadium Park To Terminals From Terminals Proposed Action Logan Airport	**Proposed Action** Existing station platforms remain and will be used by buses on at-grade roadway which connects to all terminals In the future, connections could be made by a rubber-tire people mover on Blue Line connection to Central Airline terminal (CAT)  Proposed Action - Bus Doors On Left From Airport To Boston From Boston To Airport	Provides across-the-platform transfer without relocation station Excellent interface between station, community and airport

Source: B/PB and MDPW

Water, Air, Noise Impacts	Land Use/Urban Design	Parkland And Historic Resources Impacts	Construction
Most air/noise impacts since all idling buses on same side of station	Does not provide enhancement of station interface with airport or community No impact as existing configuration maintained	Continued use of inbound access road to airport prevents expansion of East Boston Memorial Stadium Park to south	
Least air/noise impacts	Considerable adverse impact to land use due to Delta Reservations Center being taken	Inbound access road to airport	
Least air/noise impacts	Favorable impacts on station neighborhood due to easier access		

Part IID – Further Design Modifications Currently Under Consideration

Part IID

FURTHER DESIGN MODIFICATIONS CURRENTLY UNDER CONSIDERATION

Part II of the Artery/Tunnel Project SEIS/R, Sections B and C, discusses alternative design options and other design refinements to the 1985 FEIS/R Preferred Alternative which were considered in developing the 1990 SEIS/R Proposed Action. Section D briefly discusses further possible design modifications to the Proposed Action currently under consideration.

These possible design modifications are being considered as a result of the continuing process of review and improvement and in response to comments from affected communities, public agencies, and the FHWA. In particular the Department is currently examining a series of possible design refinements based, in part, on the results of the ongoing value engineering process. The FHWA has formally mandated a process known as value engineering for major highway projects such as the Artery/Tunnel Project. In this process, the project proponent (i.e., the Department) is required to engage the services of a group of engineers who are independent of the project, and who can give peer level critiques of the proposed engineering designs. In addition, formal public input delivered to the Department during the SEIS/R process for the South Boston Haul Road has yielded valuable design criticisms which would affect the final design of the Artery/Tunnel Project in the South Boston area.

The goals and objectives of these potential design changes are described below for each affected subarea: the I-93/I-90 Interchange and Massachusetts Avenue Interchange Area, the South Boston/South Boston Bypass Road Area, and the East Boston/Logan Airport Area.

As these design modifications are evaluated and their environmental impacts assessed, they will be presented to communities and agencies for review and comment. The technically feasible, environmentally beneficial, and publicly supported recommendations will be included in the Proposed Action in the Final SEIS/R for the project.

1 I-93/I-90 INTERCHANGE AND MASSACHUSETTS AVENUE INTERCHANGE AREA

In the Proposed Action, the off-ramp from I-90 westbound to I-93 and local connections occurs from the left lane. Design engineers have long taken the position that major moves to and from the signed interstate highway facility should occur uniformly from the right lane, which traditionally serves motorists going more slowly than those in the left lane. Accordingly, in the interchange design review process, attention has focused on a series of driver decision points which are closely spaced (i.e., westbound I-90 to southbound I-93, westbound I-90 to northbound I-93, and westbound I-90 to local streets). Therefore, further design development in the I-93/I-90 Interchange area (see Figure 1) includes the following objectives:

- o Exit ramps would leave the mainline from the right-hand lane.

o Interstate to interstate (i.e., mainline) moves would not connect to local service roads.

In addition, the City of Boston and others have stated their concerns over the proposed level of operations along Albany Street and its intersections with Marginal Road extension and Herald Street extension. This concern is particularly relevant to providing efficient flow of buses from South Station to Logan Airport, which must go through both of these difficult intersections. In the design refinement process, consideration is now being given to providing for these important traffic movements with fewer at-grade intersections having potential operational problems. In all cases, major streets to and from South Boston over the West Fourth Street and Broadway bridges, for example, would remain in operation.

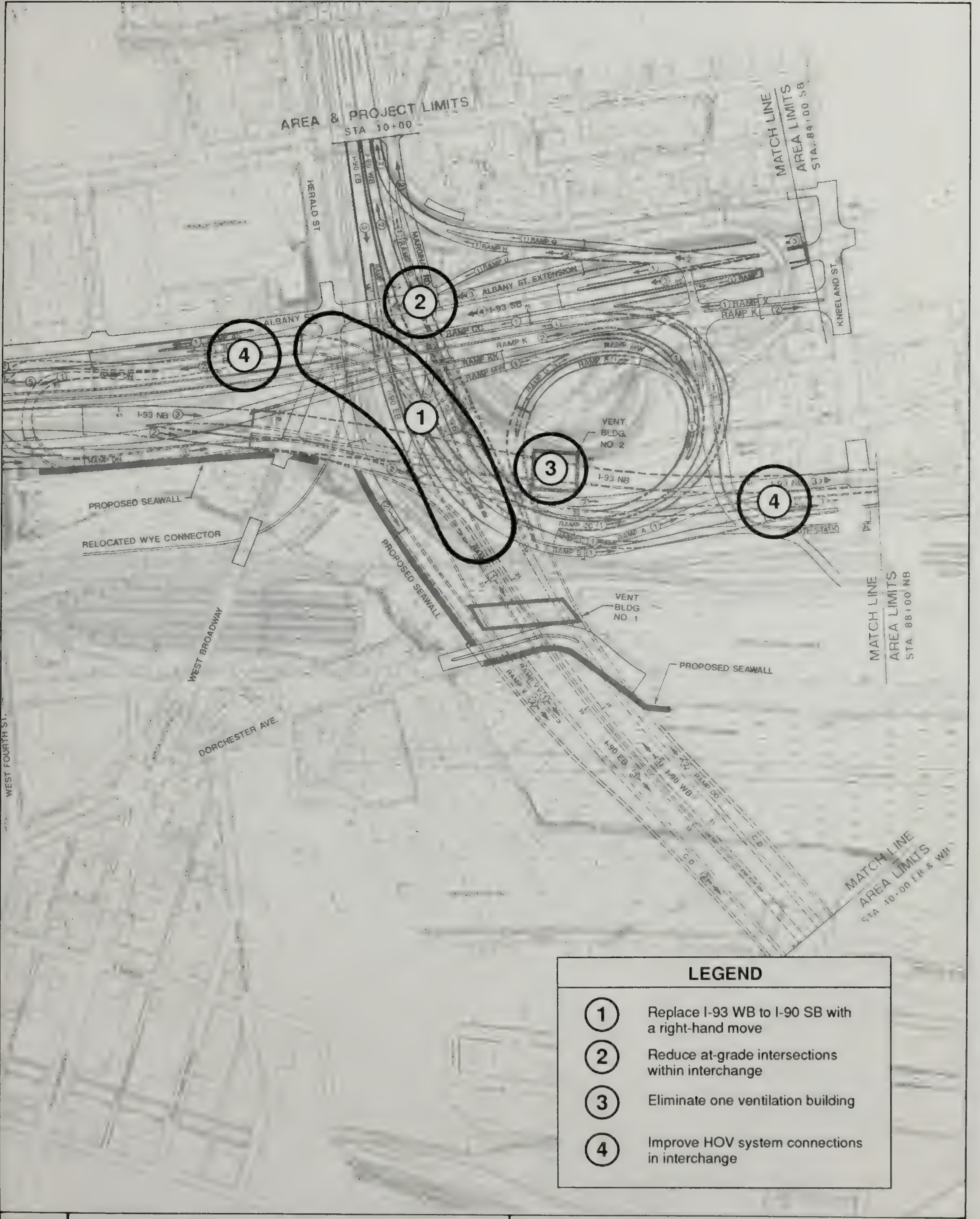
The area of the interchange is very complex where the northbound I-93 tunnel structure barrel crosses under the east-west I-90 barrel, both of which are located under the railroad tracks serving South Station. It is, therefore, desirable to review the design of the I-93/I-90 Interchange area to simplify the highway facilities while also achieving the desired levels of traffic service in this area.

In the Proposed Action, there are currently two ventilation buildings in the I-93/I-90 Interchange area, separated by only a few hundred feet. In the design refinement process, consideration is being given to eliminating the ventilation building serving the I-93 northbound roadway, and to decrease the overall length of the I-93 northbound tunnel segment. The optimum design for the ventilation of the tunnel segment under Atlantic Avenue between Kneeland and Summer Streets will, therefore, be reexamined and analyzed. This change would remove the I-93 tunnel segment in the interchange and replace it with a viaduct structure. If adopted, this change would shift the ventilation exhaust and supply requirements to another ventilation building for the remaining tunnel segment under Atlantic Avenue. The viaduct structure would decrease fill requirements in Upper Fort Point Channel as well as reduce impacts to water resources. In addition, these changes may reduce visual impacts and costs.

Finally, an additional important objective of these possible design changes is to integrate the I-93 and the I-90 high-occupancy vehicle (HOV) systems without compromising the truck route function of the South Boston Bypass Road. Of particular concern is bus travel time reliability, which is being addressed by seeking to improve the directness of the HOV system, particularly the South Station Transportation Center/Logan Airport moves. Accordingly, design changes to the HOV system in the area of the I-93/I-90 Interchange, such as improving the I-90 eastbound to I-93 southbound move, are under consideration.

2 SOUTH BOSTON/SOUTH BOSTON BYPASS ROAD AREA

The overall goal of design changes under consideration to the South Boston interchange (i.e., I-90/South Boston Bypass Road/service roads to Northern Avenue) is to simplify the alignment and thereby increase the directness of travel and reduce land use impacts (see Figure 2). Specific objectives include narrowing the right-of-way and reducing land acquisition, which will facilitate the potential for air rights and adjacent development by others. The City of Boston has observed that the proposed interchange design in the area of Summer Street would make it increasingly difficult to carry out its specific development plans in the area.



LEGEND

①	Replace I-93 WB to I-90 SB with a right-hand move
②	Reduce at-grade intersections within interchange
③	Eliminate one ventilation building
④	Improve HOV system connections in interchange

FIGURE
1

Possible Design Refinements Under Consideration – I-93/I-90 Interchange And Massachusetts Avenue Interchange Area

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

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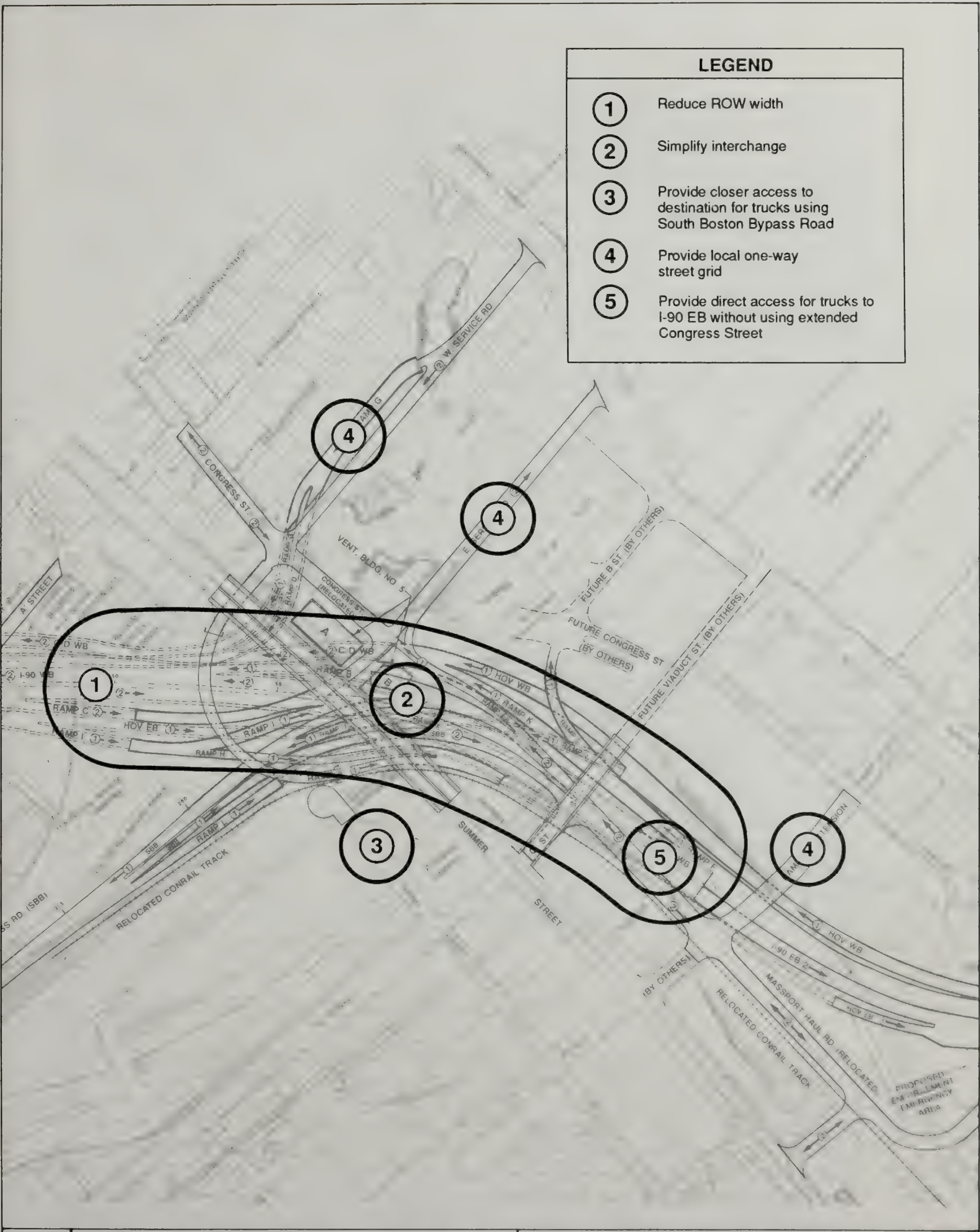


LEGEND

①	Reduce ROW width
②	Simplify interchange
③	Provide closer access to destination for trucks using South Boston Bypass Road
④	Provide local one-way street grid
⑤	Provide direct access for trucks to I-90 EB without using extended Congress Street

FIGURE 2 **Possible Design Refinements Under Consideration – South Boston/South Boston Bypass Road Area**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

In the Proposed Action, the ventilation structure serving the Seaport Access Road segment of I-90 is located in two parts (intake and exhaust functions) immediately to the north of Summer Street. The Boston Redevelopment Authority (BRA) and the City of Boston have stated their intentions to build a terraced, landscaped park immediately along this stretch of Summer Street, and have requested that this location be reanalyzed in the design refinement process leading to the final design. Consideration is now being given to the simplification of the I-90 design in this area, resulting in a net decrease in the amount of linear feet of highway lanes in tunnel. This, in turn, would allow a decrease in the size of the ventilation structure. Initial examination of this issue suggests that a simplified, narrowed configuration for I-90 in this area would create additional sites for potential use for a ventilation building. Similarly, the ventilation building could remain in virtually the same location as described in the Proposed Action. The final location for the ventilation building in this area will be determined after gaining input from the City, the BRA, and from the local abutters to the project.

The second objective is to reduce the number of decision-making points within a short distance for drivers in the interchange. This can be accomplished by deleting highway ramps which appear not to be absolutely necessary to achieve the desired levels of service. The result would provide for major traffic flows in a clearer, simpler manner.

Particular attention has been given by the public during the SEIS/R preparation process to the use of the South Boston Bypass Road by noncommercial HOVs (i.e., carpools without professional drivers). Public comment has indicated concern that the Bypass Road's primary function as a truck route may be compromised if it also is used by carpools. Accordingly, the continuing design process will examine an option which returns the South Boston Bypass Road to its originally requested function by the citizens of South Boston (i.e., for commercial vehicles only). This examination will involve decreasing the Bypass Road's direct connections to I-90 and increasing its ability to serve local commercial and industrial destinations by enabling trucks to exit/enter the road closer to destinations without using local residential streets.

Other design changes under consideration include reexamining the role of surface connection streets to achieve an alternating one-way city street grid system in the area between Summer Street and Northern Avenue. This grid system would incorporate the east and west service roads between I-90 and Northern Avenue. In addition, consideration is being given to providing ramp access for local trucks direct to eastbound I-90 without using the City's proposed easterly extension of Congress Street.

3 EAST BOSTON/LOGAN AIRPORT AREA

Consideration now is being given to decreasing the amount of viaduct upon which the I-90 connector road and the toll plaza area would be located. The lowering of the profile of this segment of this project (between the Third Harbor Tunnel portal and Route 1A) would result in an at-grade facility, eliminating 40,000 lane-feet of viaduct structure. The result would be a less intrusive highway facility along the edge of the East Boston Memorial Stadium Park. This lower profile would reduce visual impacts substantially. In addition, the proposed noise barrier along the edge of the park would be more effective, as the noise source would be at grade directly behind the barrier, rather than above it on the viaduct structure.

Consideration also is being given to reducing the width of the I-90 tunnel section under Bird Island Flats by removing the breakdown lanes. This reduction in width would result in a smaller tunnel box reducing the amount of structure to be built, the amount of materials to be excavated, and the degree of encroachment of construction activities on the adjacent Massachusetts Technology Center and airport operations.

Further design changes may be considered to project connections to the Logan Airport circulation system as a result of the continuing and ongoing coordination of the Department with Massport's Logan Airport Modernization Program. These changes, if any, would occur over time. (See Figure 3 for the location of the above design changes.)

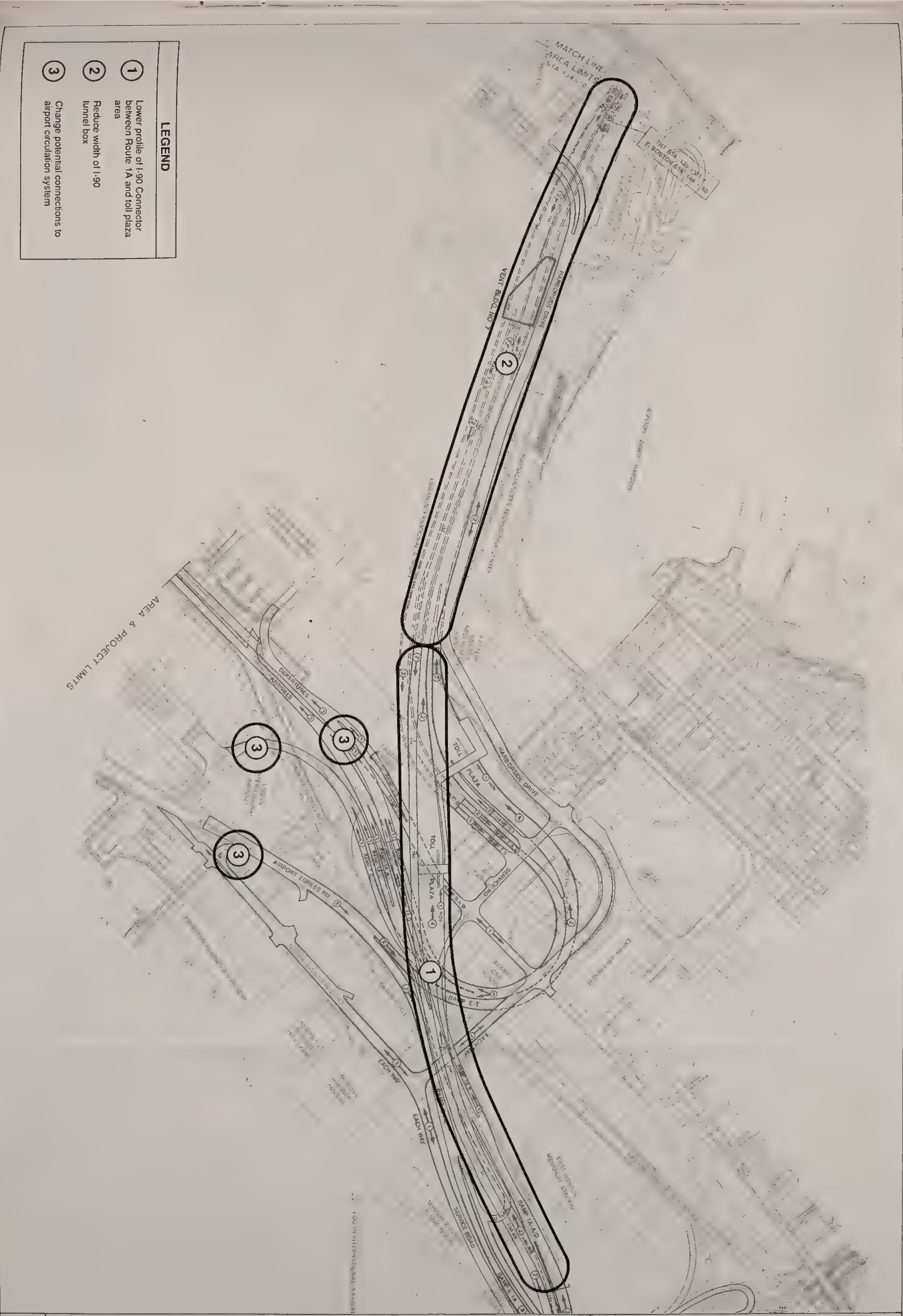

LEGEND
① Lower profile of I-90 Connector between Route 1A and toll plaza area
② Reduce width of I-90 tunnel box
③ Change potential connections to airport circulation system
MATCH LINE
AREA LIMITS
THT STA
E. BOSTON STA
HARBORSIDE DRIVE
VENT BLDG. NO. 7
AREA & PROJECT LIMITS
DEPARTURES
ARRIVALS
TOLL
PLAZA
HOV
SERVICE RD
AIRPORT EGRESS RD
RAMP E-T
EACH WAY
SERVICE ROAD
RAMP 1A-A/D
RAMP E-1A
EAST BOSTON MEMORIAL STADIUM
LOGAN INTERNATIONAL AIRPORT
1
2
3

FIGURE
3

Possible Design Refinements Under Consideration – East Boston/Logan Airport Area Alignment

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

FHWA-MA-EIS-82-02-DS2

CENTRAL ARTERY (I-93)/
THIRD HARBOR TUNNEL (I-90) PROJECT

DRAFT
SUPPLEMENTAL
ENVIRONMENTAL IMPACT STATEMENT/REPORT AND SUPPLEMENTAL FINAL SECTION 4(f) EVALUATION

PART III
- **Section 4(f) Evaluation**

Federal Highway Administration
Massachusetts Department of Public Works

PART III

SECTION 4(f) EVALUATION

1 INTRODUCTION

Section 4(f) of the Department of Transportation Act of 1966 states that no Federal Highway Administration (FHWA) action will use land from a significant publicly owned park, recreation area, or wildlife and waterfowl refuge, or any significant historic site, unless (1) there is no feasible and prudent alternative to the use of land from the property; and (2) the Proposed Action includes all possible planning to minimize harm to the property resulting from such use.

Portions of parkland, and certain historic resources would have been permanently or temporarily used by the Central Artery (I-93)/Third Harbor Tunnel (I-90) Project (Artery/Tunnel Project) as described in the 1985 FEIS/R. In the refined engineering which has been undertaken since 1985, it has been possible to avoid or reduce some of these impacts. These resources, project impacts and mitigation measures are described in this Section 4(f) Evaluation. Parklands are discussed first, followed by historic and archaeological resources.

This chapter addresses the 4(f) effects of the Proposed Action and, as to the Area North of Causeway Street, consistent with the purposes of this discussion, the relevant features of three alternative schemes for crossing the Charles River which are described also in Chapter 1 of Part II of this SEIS/R. This chapter also addresses Spectacle Island, one of the alternative sites identified since the FEIS/R for potential materials disposal in connection with the Proposed Action, as presented and analyzed in Chapter 4 of Part II of this SEIS/R.

In addition, this chapter updates the 1985 Section 4(f) information and mitigation plans regarding the 4(f) properties identified in the FEIS/R for the Artery/Tunnel Project. Design refinements to the Proposed Action have eliminated or substantially reduced impacts on these properties.

Projectwide alternatives to avoid Section 4(f) property were described in the FEIS/R, and that discussion continues to apply to the no-build alternative and other more widely ranging concepts to avoid the 4(f) properties described there. The FEIS/R documented the fact that the no-build alternative and projectwide alternatives not including the depression and widening of the Central Artery did not satisfy the basic transportation objectives of the project, and were therefore rejected.

The FEIS/R also documented that complete avoidance is not possible for resources located in close proximity to regional transportation facilities to which the Project must connect. Connection to the Project requires some modifications to Storrow Drive and Leverett Circle, which lie within Charles River Reservation. Part of Paul Revere Landing Park lies under the existing I-93 Charles River Crossing, and all alternatives which improve this crossing would use some land in this park, because it is in the only available corridor between the Central Artery and the I-93/Route 1 interchange. East Boston Memorial Stadium is adjacent to Logan Airport and Route 1A; although permanent use is avoided, construction of the project interchange with Route 1A can only be accomplished within a tightly constrained area that provides access to the park, temporarily affecting access. The Fort Point Channel Historic District lies directly between the Massachusetts Turnpike (I-90 and all possible routes for a Seaport Access Road and a tunnel to Logan Airport. These issues are more fully discussed in the 1985 FEIS/R, Section 4(f) Evaluation.

Avoidance alternatives and design refinements specifically intended to minimize harm are discussed in more detail in the appropriate sections below.

2 PARKLANDS

There are four publicly owned parks that will be affected by the Proposed Action because of a permanent taking or a construction period easement: two parks in the Area North of Causeway Street, the East Boston Memorial Stadium Park, and a designated proposed park at Spectacle Island (see Figure 1). Two other parks in the Area North of Causeway Street are not affected by the Proposed Action but would potentially be affected by alternative design schemes for the Charles River crossing which are discussed here. Nine additional parks are near the Proposed Action, but no portion of these recreational areas will be used or impaired by the project (see Section 2.4 and accompanying figure.)

The approval of land conversions under Section 6(f) of the Land and Water Conservation Fund Act is unnecessary since none of the affected parkland was acquired under this Act.

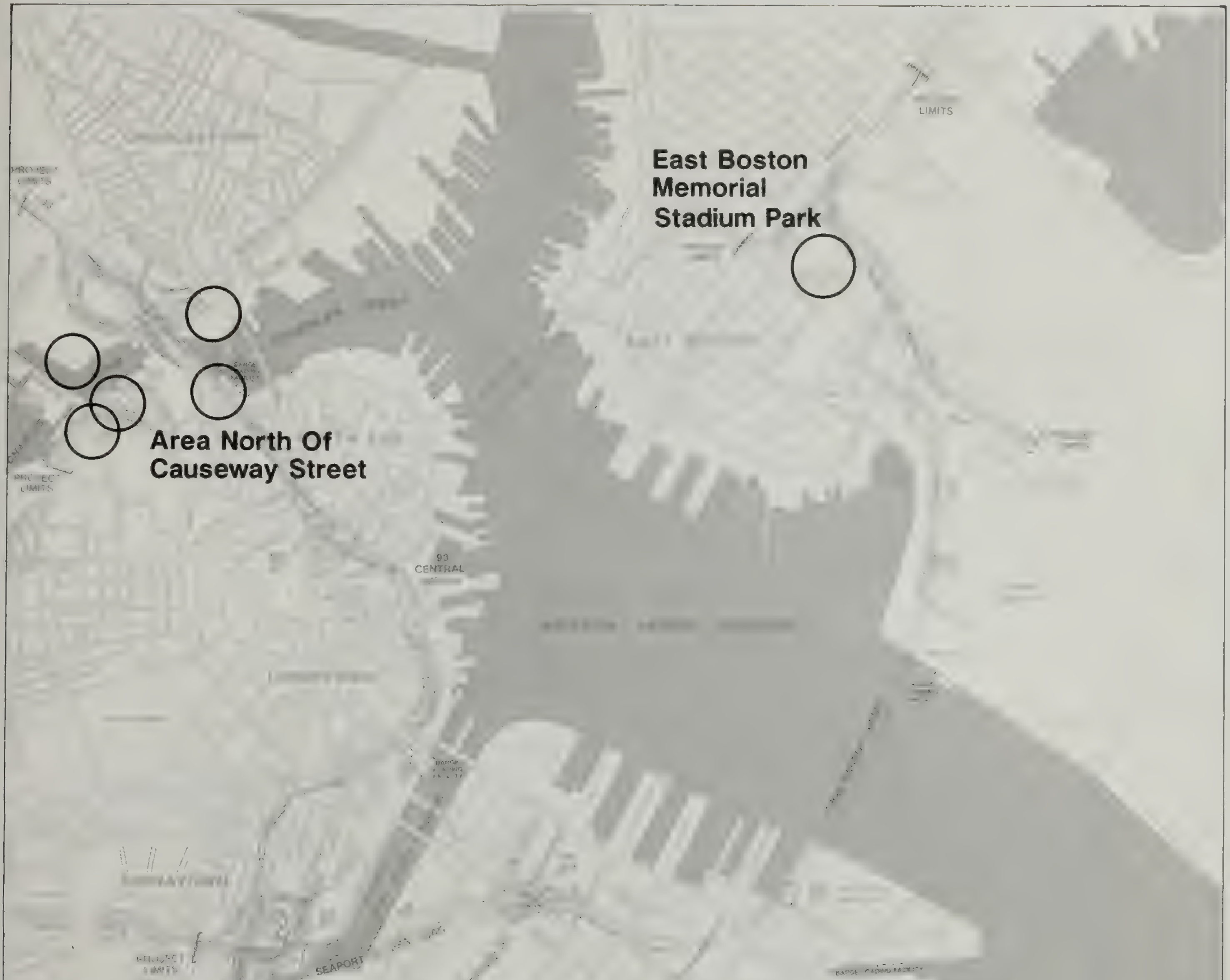
2.1 AREA NORTH OF CAUSEWAY STREET

2.1.1 Proposed Action And Other Schemes Considered In The SEIS/R

Following the 1985 FEIS/R, the Charles River crossing elements of the Preferred Alternative (5A Modified) were subjected to further study to address both operational and environmental concerns. A total of 31 design options were explored. (See Chapter 1 of Part II of this SEIS/R.) Three options, S Modified, T Modified, and Z Modified, were selected as the most reasonable and promising representatives of the design approaches pursued during this effort (see Figure 2). None of the other options studied would avoid or reduce use of 4(f) resources while maintaining acceptable highway standards. Some options which did not meet design standards for acceptable traffic weaving operations, such as the unmodified versions of Schemes S and T, used marginally less 4(f) land than the modified versions with acceptable design; (for example, unmodified Scheme T, which has left-hand off-ramps, would use 0.62 acres of Paul Revere Landing Park compared to 0.77 acres in Scheme T Modified which has right-hand off-ramps). None of the rejected options avoided 4(f) impacts, nor could they be modified to do so.

Schemes 5A modified, S Modified, T Modified, and Z Modified are fully described and analyzed in comparison to the original Preferred Alternative, 5A Modified, in Chapter 1 of Part II. As discussed there, scheme Z Modified was determined to be superior to 5A Modified, S Modified, and T Modified, and it has been incorporated into the Proposed Action in the Area North of Causeway Street.

Scheme 5A Modified (the Preferred Alternative alignment in the FEIS/R) would have located the ramps between the Central Artery and Leverett Circle in a tunnel along the south bank



FIGURE

1

Location Of Parkland Addressed In Section 4(f) Evaluation

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

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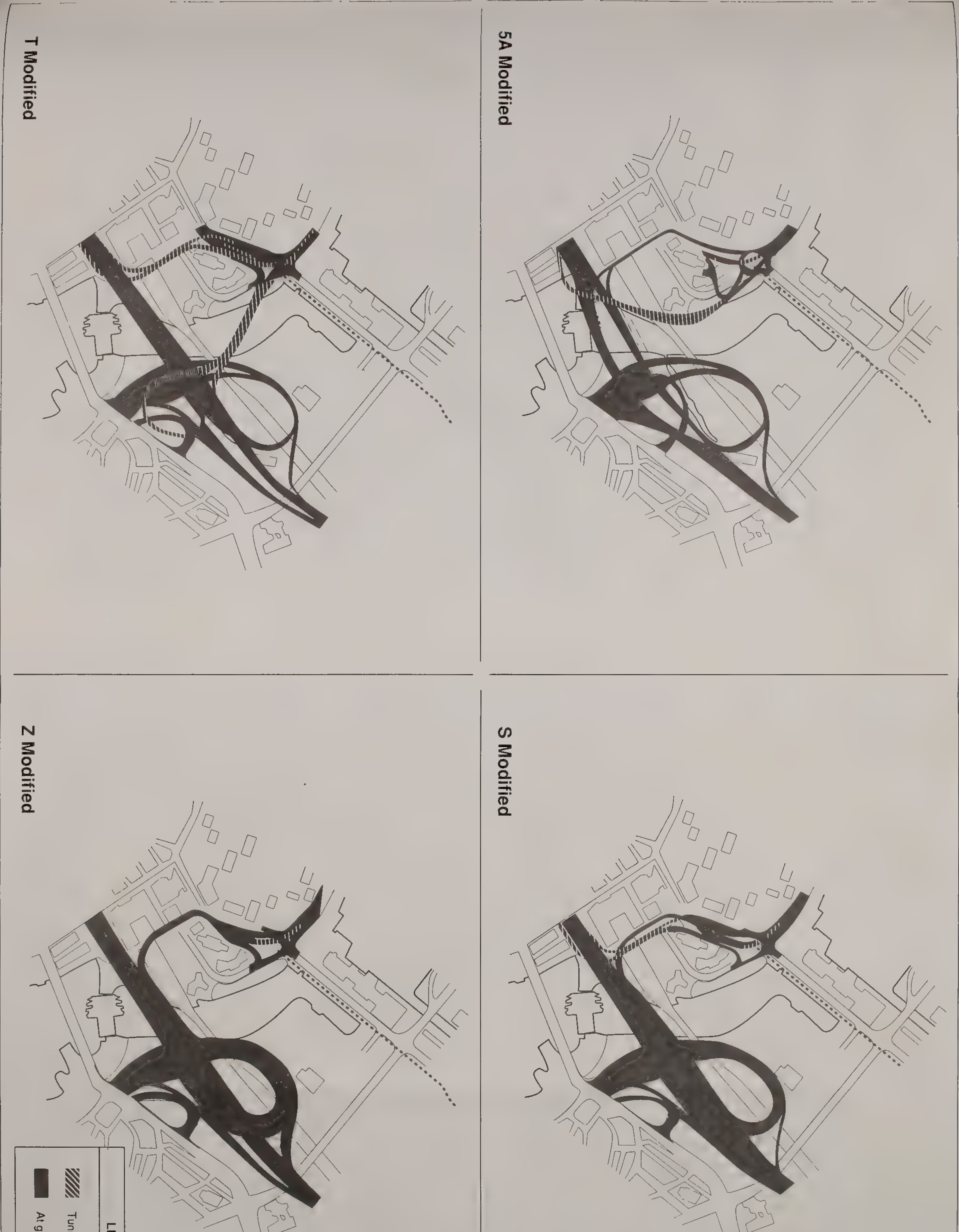


T Modified

5A Modified

Z Modified

S Modified

FIGURE 2

Design Options – Area North Of Causeway Street

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93) TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS R

of, and partially in, the Charles River. In addition, it would have placed the new Charles River bridges on either side of the existing Central Artery high-level truss bridge.

Under scheme S Modified, the Central Artery Leverett Circle ramps would be shifted from alongside and within the river to behind Boston Garden in tunnels north of and adjacent to the existing ramps. The southern movements would have remained in tunnel, as was the case with scheme 5A Modified, under the railroad tracks at North Station. In addition, the alignment of the bridges would be shifted westerly to avoid the Charles River dam, and the northbound and southbound mainline lanes would be parallel.

Scheme T Modified would provide a direct connection between Leverett Circle/Storrow Drive and the I-93/Route 1 interchange via new tunnel structures under the Charles River. The tunnel would provide only for movements to and from the north. Southerly movements would remain in a tunnel behind Boston Garden, as in scheme S Modified. The new Charles River bridges, moreover, would be the same as in scheme S Modified, i.e., west of the existing Central Artery high-level truss bridge, with parallel alignments for northbound and southbound bridges.

Scheme Z Modified (the Proposed Action in the Area North of Causeway Street) will begin from the south in this area at the portal of the tunnel section at Causeway Street. The roadway will climb a grade north of Causeway Street in an open boat section and a retained fill section to a bridge structure crossing the Charles River. The segment of the Proposed Action which will affect parkland in this area is described in detail in Section 2.2.1 of the SEIS/R (Part I), Area North of Causeway Street. Across the river, the Proposed Action will be an elevated structure joining the Central Artery North Area (CANA) Project in Charlestown (I-93/Route 1 interchange), and will end at the project's northern limit on I-93 at a point north of the Gilmore Bridge. New ramps will be included, connecting the Central Artery with Leverett Circle/Storrow Drive on an alignment behind the Boston Garden.

The purpose of and need for the Proposed Action are discussed in detail in Chapter 1 of the SEIS/R (Part I). In addition, the FEIS/R for the Artery/Tunnel Project contains a discussion of the need for the project, its logical termini, project alternatives considered and eliminated, and reasons why the no-build alternative could not meet project objectives. These investigations are not repeated in this revised and supplemental Section 4(f) Evaluation. Rather, new design schemes which were considered subsequent to the FEIS/R are addressed in this Section 4(f) Evaluation. (Also see Chapter 1, Part II, of this SEIS/R for more detailed discussion of these design schemes.)

Four MDC parkland areas are identified as Section 4(f) resources in the Area North of Causeway Street: Leverett Circle/Storrow Drive; designated Nashua Street parkland; parkland at the former GSA site; and Paul Revere Landing Park (see Figure 3). These properties, and parkland impacts of the Proposed Action and other design schemes in the Area North of Causeway Street, are described in the following sections. Mitigation of parkland impacts is discussed for the Area North of Causeway Street as a whole in Section 2.1.8.

2.1.2 Leverett Circle/Storrow Drive (Charles River Esplanade)

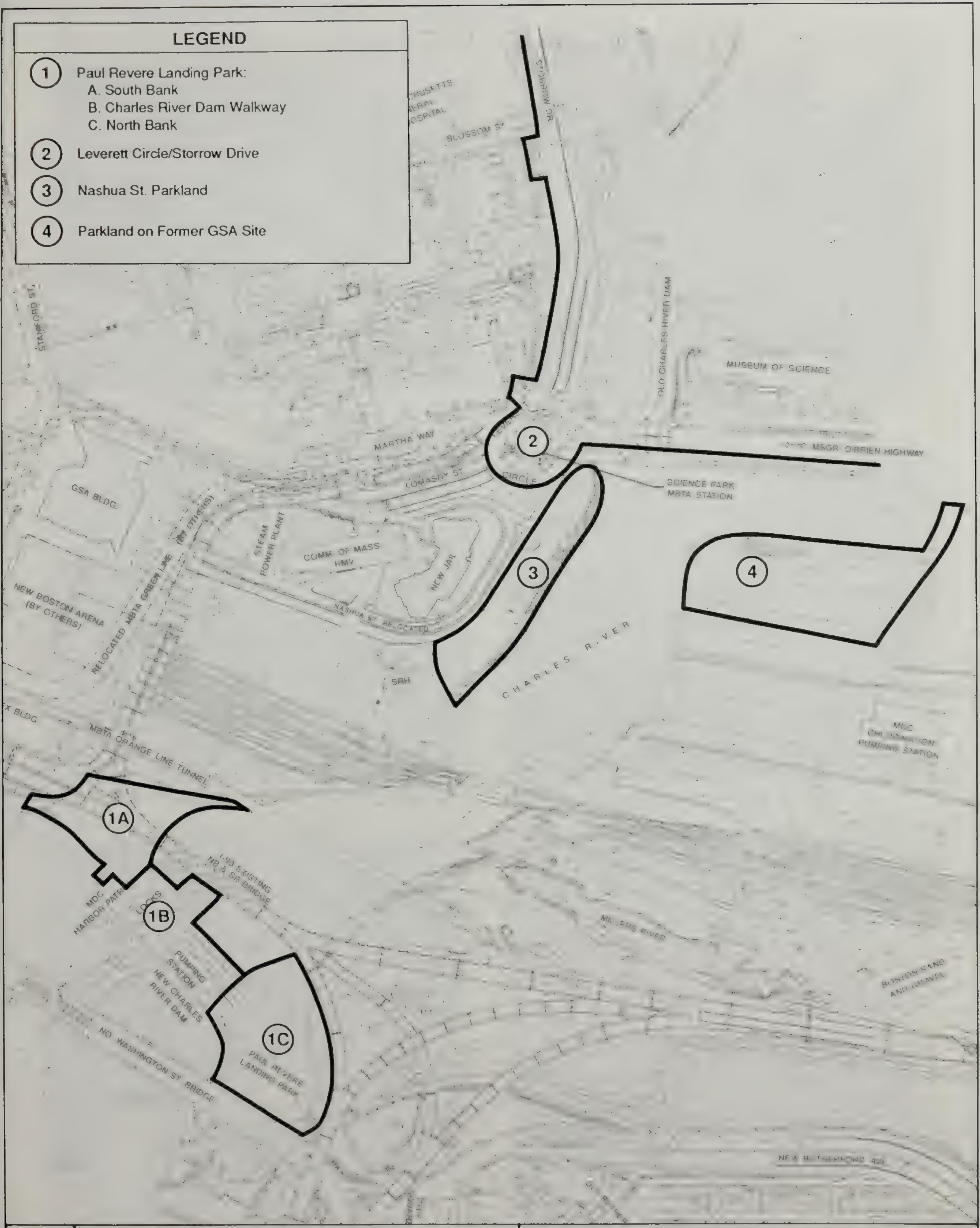
Description Of The Section 4(f) Property. The Leverett Circle/Storrow Drive intersection is an area of approximately 1 acre lying within the southeastern boundary of the Charles River Reservation, a 17,000-acre public parkland extending along both sides of the river between the old Charles River dam (O'Brien Highway) and Watertown to the west. The Boston portion of this reservation lying between Storrow Drive and the Charles River is called the Esplanade. The part of the Esplanade park near Leverett Circle is heavily used and contains a pedestrian/bicycle path, a swimming pool, a wading pool, a baseball field, a football/soccer field, a tot lot, and, closest to the Project Area, two tennis courts. A police station and associated parking are located adjacent to Leverett Circle. The Reservation is owned and administered by the Metropolitan District Commission (MDC), the regional park agency with jurisdiction.

Neither Leverett Circle nor Storrow Drive is used for recreation. Rather, Storrow Drive serves general automobile traffic including heavy commuter volumes, and Leverett Circle is a busy intersection of Storrow Drive with O'Brien Highway, Central Artery ramps, and local streets providing access to the North Station area and Government Center. The south sidewalk and planting strip along Storrow Drive runs roughly parallel to the Esplanade pedestrian path but is separated from it by eight lanes of traffic and serves general pedestrian circulation, not passive recreation. The overpasses at Leverett Circle and Blossom Street are, however, used by bicyclists and pedestrians.

Leverett Circle is a landscaped traffic rotary at the intersection of Storrow Drive (a riverside parkway), O'Brien Highway, Nashua Street, Lomasney Street, Martha Way, and the approach ramps to the Central Artery (see Figures 4 and 5). The Science Park Green Line light rail transit station owned by the Massachusetts Bay Transportation Authority (MBTA) is located on an elevated structure that bisects the Circle. Two pedestrian bridges over Storrow Drive and Leverett Circle link the station with Charles River Park private housing development and the Charles River Esplanade riverside park. Pedestrian access to the approximately 28,000-square-foot grassy area within the Circle is not available as it would be unsafe to cross the heavily travelled roadway that surrounds it. Peak hour traffic volumes on Storrow Drive, Nashua Street, and O'Brien Highway that feed into Leverett Circle are among the highest in the Central Business District. Further south is another pedestrian overpass at Blossom Street linking Charles River Park over Storrow Drive and the Esplanade.

Impacts On Resources By Proposed Action And Other Design Options. In scheme 5A Modified, Storrow Drive would have been widened toward the tennis courts by approximately five feet; a temporary construction easement would have been extended further into the playground but would not have prevented use of the tennis courts. In the Proposed Action, a new eastbound Storrow Drive underpass will be constructed under Leverett Circle, and the traffic rotary will be replaced by an intersection. These changes will affect MDC roadways and landscaping on the south side of Storrow Drive, but there will be no permanent or temporary use of land in the Esplanade playground.

In the Proposed Action, Leverett Circle as a traffic rotary will be reconfigured to create a redesigned at-grade intersection to accommodate surface traffic movements. A new surface ramp for traffic from new Nashua Street to the Storrow Drive/I-93 ramp will bisect the southern half of Leverett Circle. The northern half of the rotary roadway no longer needed for the new intersection will be joined to adjacent remnants of land, creating parkland that will be landscaped to enhance the intended parkland environment of the Charles River Reservation. Two small areas totalling 2,000 square feet of MDC-owned parkland adjacent to and outside of Leverett Circle also will be permanently used for the new intersection improvements, while existing pavement will be removed from other areas.



FIGURE

3

Section 4(f) Resource Area North Of Causeway Street

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

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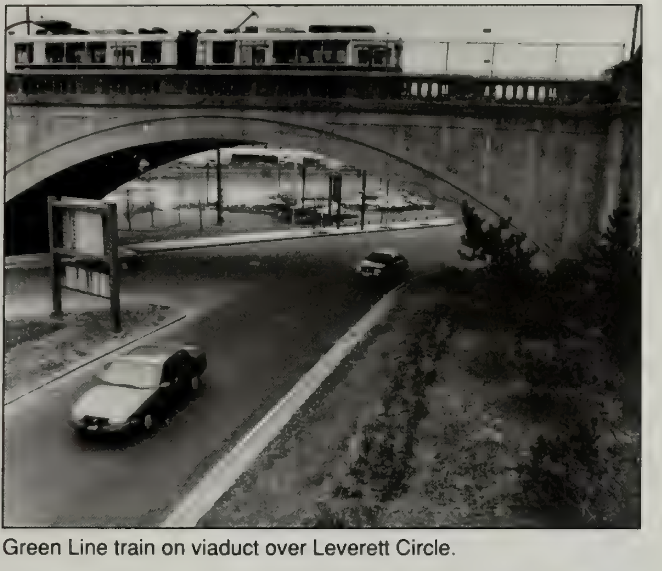
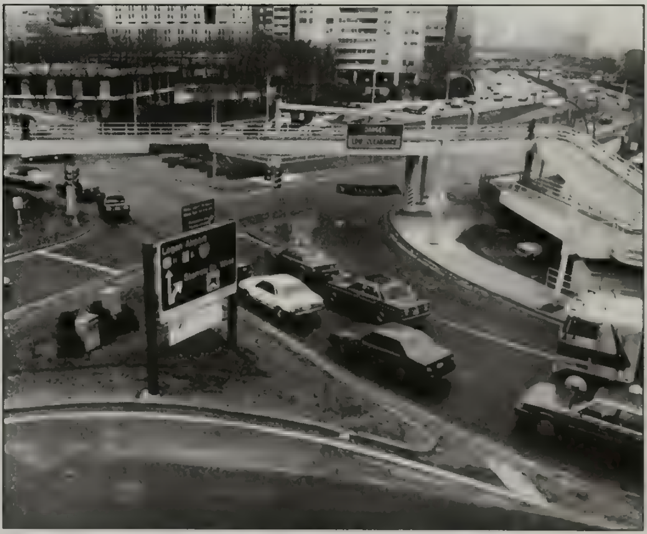

Green Line train on viaduct over Leverett Circle.

North edge of Leverett Circle rotary from MBTA elevated station. New jail under construction in background.

MBTA elevated tracks and rapid transit station above Leverett Circle.

South half of Leverett Circle looking west to Storrow Drive. Esplanade in background.

Existing westbound Storrow Drive underpass (center) and eastbound lanes (left) at Leverett Circle


West edge of Leverett Circle (left), pedestrian overpass, Storrow Drive (right) and Charles River Park development in background.

FIGURE

4

Views Of Leverett Circle And Storrow Drive

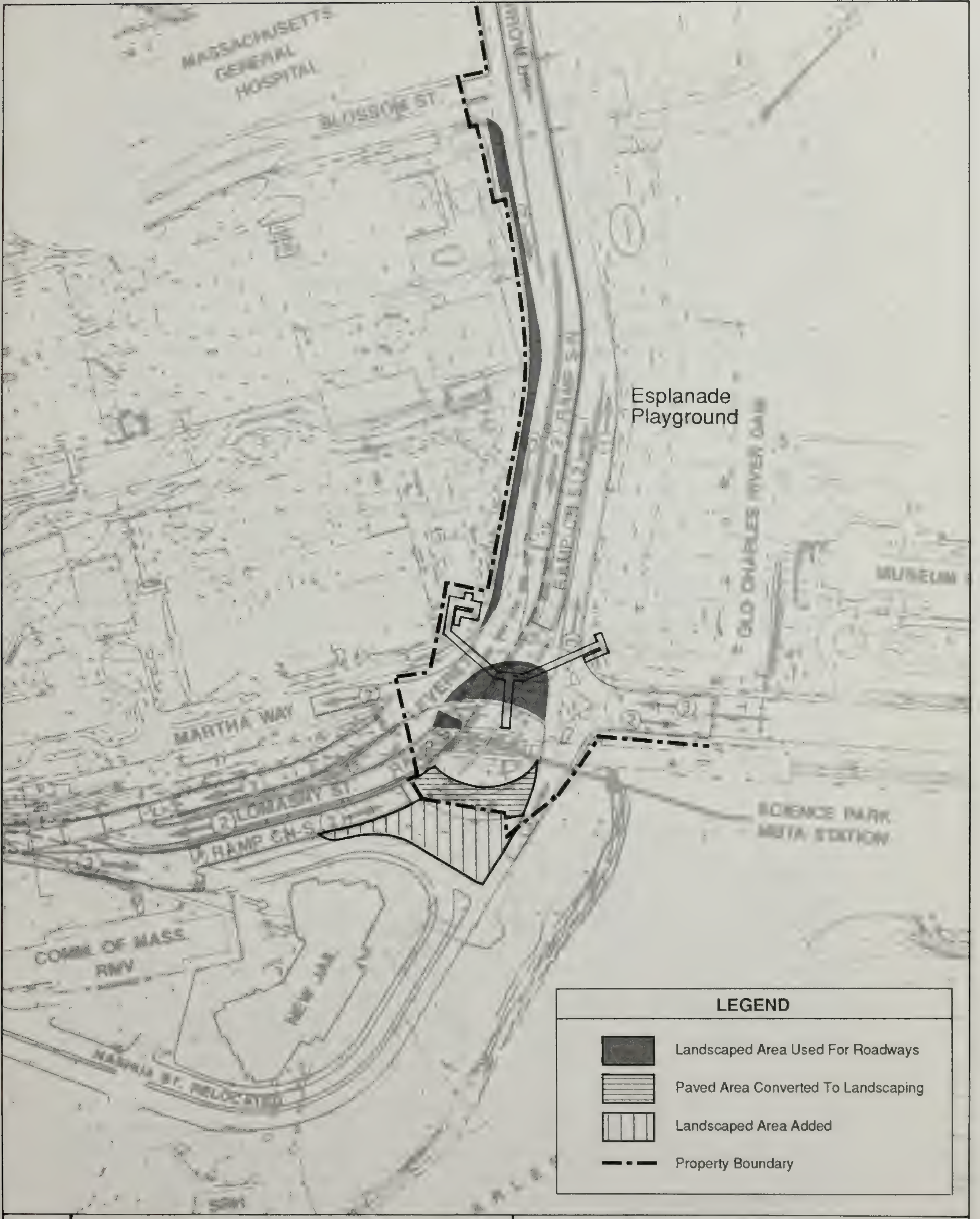


FIGURE 5

Use Of Section 4(f) Resource At Leverett Circle

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

A 11,000-square-foot (0.25 acre) strip of publicly owned land occupied by highway landscaping will be taken to widen Storrow Drive eastbound to accommodate the new transition (boat) section leading to the underpass. Reconfiguration of Leverett Circle would add 11,000 square feet of pavement (0.25 acre) but remove 8,100 square feet of existing pavement for a net increase of 2,900 square feet (0.06 acre) of pavement. The additional pavement would displace landscaping that is not actively used for recreation. The reconfiguration of the Circle also would permit the addition of 11,500 square feet of new landscaped property and a pedestrian path between Science Park station and the new Charles Street Jail and Registry of Motor Vehicles building. Permanent easements from the MDC will be required for the underpass at Leverett Circle and for the westerly transition section in Storrow Drive to maintain the facility once completed (see Figure 5). Temporary construction easements will be required within Storrow Drive and at Leverett Circle. Unlike scheme 5A Modified, there is no land acquisition on the Esplanade side of Storrow Drive. Therefore, there would be no adverse effect on recreational activity. (General pedestrian access would be improved by reconfiguration of the landscaped areas of Leverett Circle.)

It is intended that all major traffic connections to and from Storrow Drive be maintained throughout the construction period, although traffic lanes may be moved from side to side at times. The pedestrian bridges at the MBTA Science Park station will be relocated in the same area. Pedestrian access to the playground will be available via the Blossom Street pedestrian bridge during this phase of construction. If the underpass is constructed during the time that the Science Park station is not in service, due to the separate Green Line relocation project by the MBTA, then there will be no impact to transit service because of the Proposed Action. The feasibility of underpinning the station is being considered in case this should be necessary.

The Storrow Drive pedestrian crossing farther south at Blossom Street will require modification because of the planned widening of Storrow Drive. It is anticipated, however, that pedestrian access across Storrow Drive at Blossom Street will be maintained during construction except for a brief interruption of approximately 2 weeks which will be necessary to complete connections to a new bridge landing.

The Proposed Action would improve air quality in this part of the Reservation. Leverett Circle currently has relatively high concentrations of carbon monoxide (CO): 1-hour modelled concentrations in 1987 were 19.7 ppm at the intersection and 15.3 ppm midblock. 8-hour concentrations in 1987 were 13.3 ppm at the intersection and 10.2 ppm midblock. Future 1-hour and 8-hour carbon monoxide levels at Leverett Circle would be roughly 8.5 ppm and 5.6 ppm without the Project in year 2010; with Scheme Z Modified, these concentrations would be slightly lower (7.9 and 5.2 ppm respectively. Midblock 1-hour concentrations near Leverett Circle would be lower 5.0 ppm with the Project versus 7.8 ppm for 2010 without the Project; 8-hour concentrations would be similarly improved. These air quality improvements would be beneficial to nearby use of the tennis courts and other recreation facilities. (See Chapter 4 of Part I of this SEIS/R.)

Noise increases would be small. Predicted noise levels at Leverett Circle would change slightly from existing AM and PM levels of 71 and 68 dBA to year 2010 baseline levels of 74 and 68 dBA. With scheme Z Modified, these AM and PM peak hour noise levels would change to 73 and 71 dBA. (An increase of 3 dBA is the smallest that can be perceived by most people.) These changes would not impair use of nearby recreation facilities such as tennis courts nor or more distant passive uses in the Esplanade. (See Chapter 5 of Part I of this SEIS/R.)

A Section 4(f) use will occur, therefore, because of the permanent use of Leverett Circle and the temporary construction easements in the Circle, the permanent use of a 400-foot-long segment of Storrow Drive, and the temporary use of the Blossom Street pedestrian overpass, which will be modified. Although these facilities are owned by MDC, which also owns the Esplanade, they are not used for recreation. All but 0.6 acre in Leverett Circle and 0.25 acre along Storrow Drive will remain in the same use, i.e., roadway and associated highway landscaping, and additional similar area will be more available.

Scheme S Modified would use approximately the same amounts of Section 4(f) land as Z Modified, would have similar noise impacts at Leverett Circle, and greater air quality impacts, although 8-hour CO standards would not be violated. T Modified would use more land in Leverett Circle permanently and requires a temporary use of land in the Esplanade playground as a construction period detour, and it also has a greater air quality impact than Z Modified.

Avoidance Alternatives. The improved connections to Storrow Drive at the Leverett Circle bottleneck are essential to fulfill project objectives. Scheme Z Modified avoids any impact on the Esplanade, in contrast to 5A Modified and T Modified. Impact on the rotary is required by the eastbound underpass and could only be avoided by leaving intact the existing traffic problem.

2.1.3 Designated MDC Nashua Street Parkland

Description Of The Section 4(f) Property. Since the FEIS/R several State agencies have cooperated in a process of acquisition by the MDC of a riverfront parcel of approximately 100,000 square feet adjacent to Leverett Circle and the relocated Nashua Street. Nashua Street has been relocated to create a site for the Charles Street Jail, and the parcel in question has been designated for conveyance to and development by the MDC as parkland. Transfer of care and operation has been agreed to by the Division of Capital Planning and Operations (DCPO) and by the MDC and is awaiting technical amendment to earlier legislation which conveyed the property to DCPO. Because the completion of this transfer is imminent and the necessary legislation may occur prior to the completion of the Final SEIS/R, this parcel is addressed here as subject to Section 4(f).

The new parkland extends the Charles River Esplanade approximately 800 feet to the east. Timing of park improvements depends in part on the relocation of an existing helistop, which must be relocated no later than December 31, 1994, under the terms of the Chapter 91 license granted to DCPO for the construction of the Charles Street Jail. Design of park improvements on this parcel has not yet begun, and there is no current park use of the parcel. Current concepts for this parcel emphasize extension of the Esplanade with passive uses such as walking and bicycling along paths with views of the river.

Impacts On Resources By Proposed Action And Other Design Options. Scheme Z Modified (the Proposed Action) avoids all of this property. Scheme 5A Modified would have eliminated most of the value of this property by dividing the parcel and separating it from the river with open boat section ramps. The Proposed Action (Z Modified) represents an effort to eliminate these impacts and would have no impact on this property, except for construction period noise and dust from nearby work at Leverett Circle. S Modified would have no impacts except the construction impacts noted for Z Modified. T Modified would require temporary use for the duration of the project in order to construct a tunnel under the Charles River at this point; a permanent subsurface easement would be required. In addition, S Modified and T Modified would require ventilation facilities to be located in the Nashua Street area near the property.

Avoidance Alternatives. Z Modified (the Proposed Action) succeeds in avoiding the impacts of the FEIS/R Preferred Alternative (5A Modified). Scheme S Modified would be similar to Z Modified for this property. Scheme T Modified would require extensive subsurface and construction easements.

2.1.4 MDC Parkland At The Former GSA Site

Description Of The Section 4(f) Property. In 1989, the MDC acquired a parcel of land from the U.S. General Services Administration (GSA) at the northwest bank of the Charles River, opposite the old Charles River dam. The Cambridge/Boston line bisects the property which is approximately 1.8 acres in size. Most of the parcel currently is occupied by a parking lot and sheds. Design of park improvements has not yet begun, and there is no current park use of the parcel. Current concepts for this parcel emphasize extension of the Cambridge side of the Esplanade/Front system with passive uses such as walking and bicycling along paths with views of the river, and pedestrian connections to Paul Revere Landing Park and Charlestown.

Impacts On Resources By Proposed Action and Other Design Options. There is no impact on this property by any alternative considered, except that in scheme T Modified, this property might be affected by or used for a graving basin for the fabrication of tunnel segments.

2.1.5 Paul Revere Landing Park

Description Of The Section 4(f) Property. The MDC's Paul Revere Landing Park (approximately 6.5 acres) is situated on both banks of the Charles River, linked by a walkway over the Charles River dam locks.

South Bank: The approximately 3.0-acre south bank portion includes a riverside walkway, benches, four picnic tables, minimal landscaping, and a parking lot with approximately 73 spaces for vanpools and cars of MDC employees at the Harbor Patrol and the Charles River dam and pumping station (see Figures 6 through 8). Most of the land is devoted to parking. No active recreation facilities are available. The bottom of the superstructure of the existing Central Artery high-level truss bridge is approximately 50 feet above the mean high water level of the Charles River. The clearance above the park is slightly less, and the bridge visually dominates the park and casts permanent shadows on it. The park is virtually unused for passive recreation except for access to the walkway across the dam. It is isolated from Causeway Street, and access to it is not marked by signs. The Department has easement rights of access in and adjacent to the MDC-owned park for maintenance and other purposes associated with the overhead highway structure.

Charles River Dam Walkway: Each day, approximately 500 pedestrians cross the Charles River dam between Charlestown and Causeway Street, according to the CANA project construction site manager, on a unique walkway over the lock gates (see Figures 6 through 8). Additional pedestrian access over the dam is provided through an exhibition gallery along the east side of the dam building. The new Charles River dam was built in 1978 as a flood control facility, functionally replacing the old Charles River dam (at O'Brien Highway) further upstream. It is located between the Charlestown (North Washington Street) and Central Artery high-level bridges. The dam includes three locking facilities: two recreational locks, each 200 feet long and 25 feet wide for pleasure craft, and one larger lock, 300 feet long and 40 feet wide, for commercial vessels. The annual number of lockings of pleasure craft is estimated to be 30,000 vessels, reaching a peak flow of 3,000 during the Fourth of July weekend. Annual commercial lockings are far less frequent, and are estimated to be 300 vessels (approximately one per day). Commercial vessels include oil, construction, and fireworks barges, the latter making their annual round trip through the lock on the Fourth of July for the celebration further upstream. A flood control pumping station is located on the north side of the dam, and the MDC Harbor Patrol facility is found on the south side.

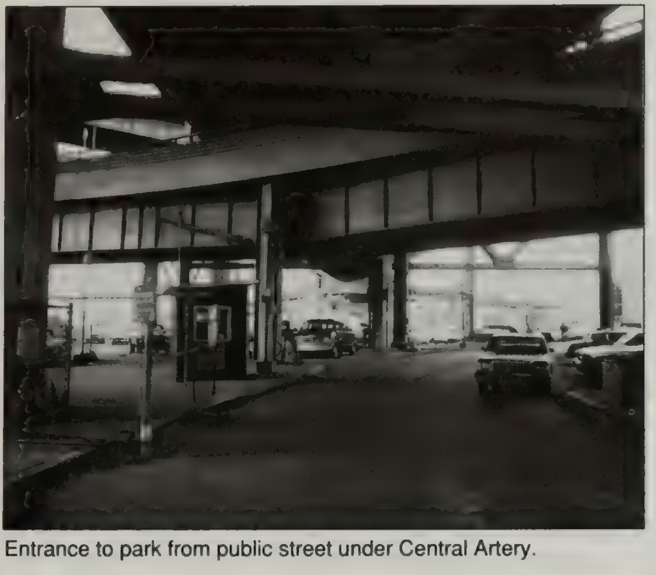
North Bank: As described in the CANA Section 4(f) Evaluation, the 3.3-acre portion of the park on the north bank of the river was constructed in 1978 along with the Charles River dam. Abutting the park is a 0.3-acre area which formerly was part of the park and now is owned by the Department for construction of the CANA project, a separate undertaking. Some of this area previously was a part of the park. The remaining parkland is landscaped and includes lighting and walkways. The park provides a pedestrian connection between City Square in Charlestown and the walkway across the Charles River dam locks to Causeway Street. This part of the park is being temporarily used for construction of the CANA project. Prior to CANA construction, this portion of the park served for passive recreational uses, primarily walking and sitting with views of the river, and access to the walkway across the dam for jogging, bicycling, and walking. The park is fenced temporarily, and it closes each evening at 6:00 PM. Following CANA construction, the park will be reconfigured and landscaped for passive use in a manner similar to its previous state.

The CANA project proposed expansion of the park to mitigate construction impacts and to replace land taken by that project. This CANA mitigation and replacement land will expand the north bank portion of the park by 1.1 acres to a total of approximately 4.4 acres. As described in the CANA 4(f) Evaluation, park boundaries would be extended to the west to include land under the existing I-93 bridge and then-existing ramps.

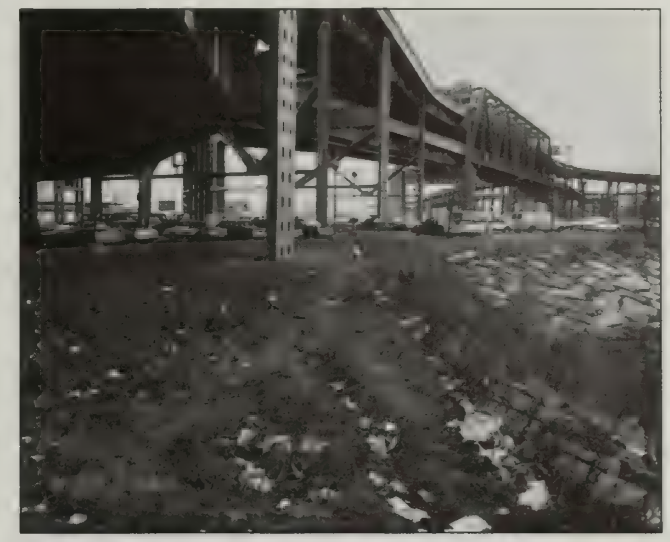
In addition to the existing park, and CANA 4(f) mitigation/replacement land, certain additional land acquired and currently used by the Department for transportation purposes for the CANA project is proposed to be improved as parkland for mitigation purposes following completion of that project. Although this land is not subject to Section 4(f), this area is addressed in the comparison of the effects of the alternative Charles River crossing schemes in Chapter 1 of Part II of this SEIS/R, and addressed in the context of mitigation proposals for Paul Revere Landing Park in Section 2.1.8 below.

Impacts On Resources By Proposed Action And Other Design Options.

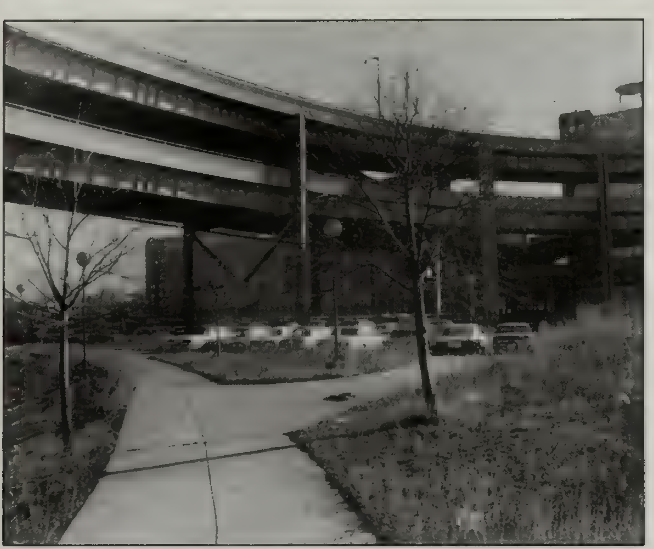
South Bank: Under scheme 5A Modified, approximately 0.9 acre of this area would have been used by elevated structure, and subsurface connections to Storrow Drive would have



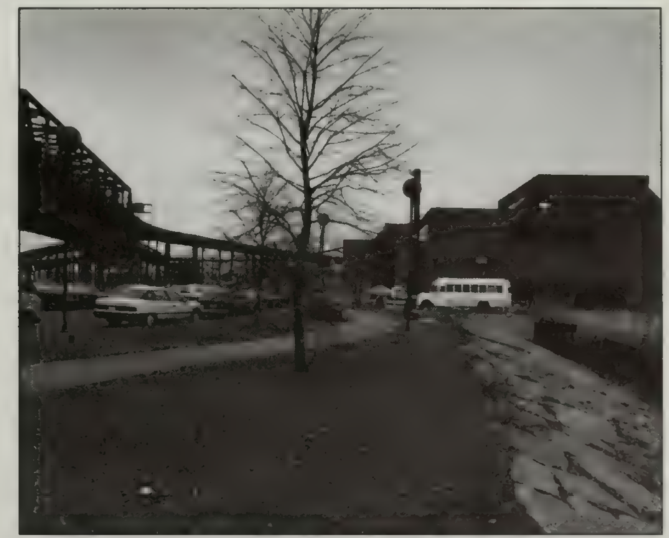
Entrance to park from public street under Central Artery.



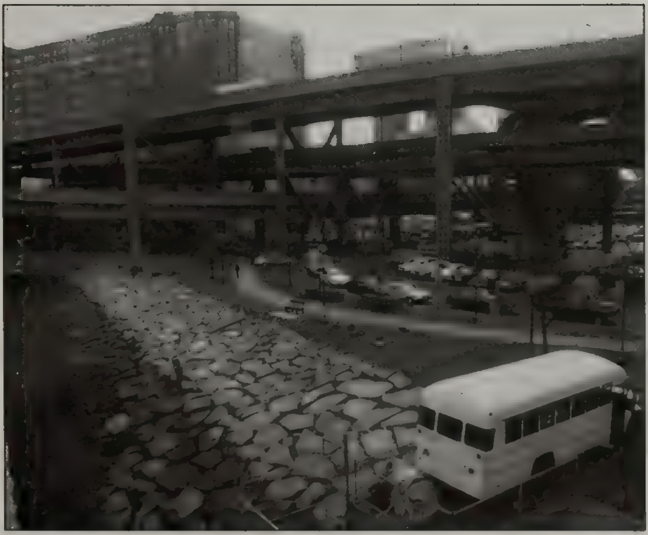
Southeast edge of park.



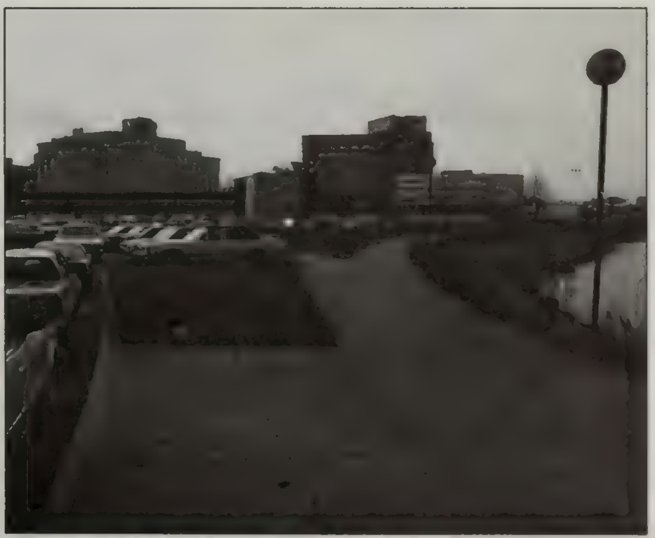
Riverside walkway.



Park's eastern edge (right). Charles River Dam and Harbor Police building in background.



Park consists primarily of parking spaces and riverside walkway on either side of Charles River Dam.



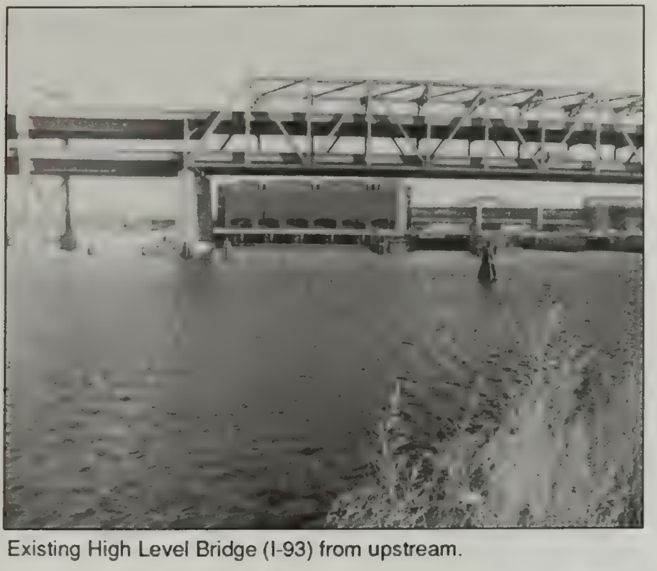
Riverside walkway connecting with walkway on MBTA trestle to right of photo.

FIGURE

6

Views Of Paul Revere Landing Park,South Bank Of River

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

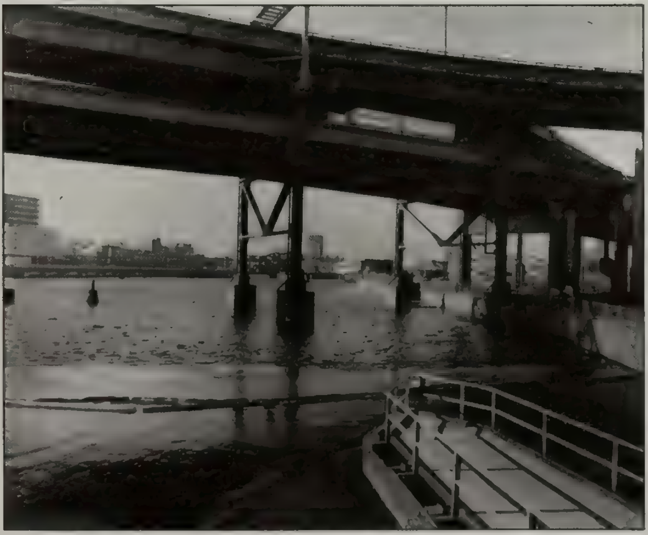


Existing High Level Bridge (I-93) from upstream.

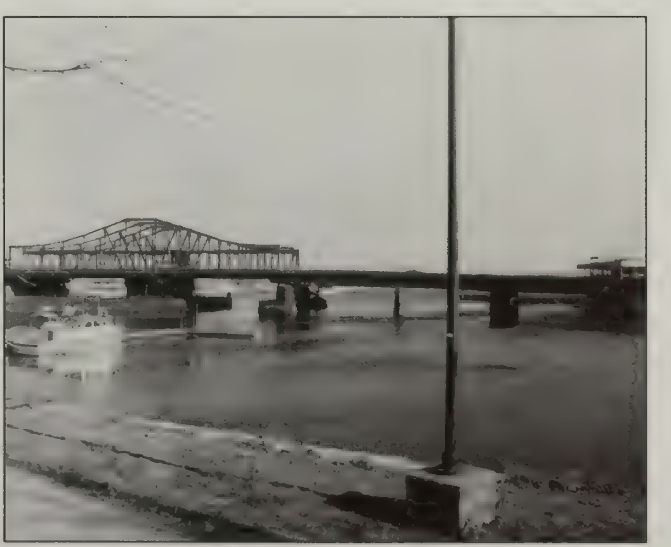
Existing High Level Bridge from upstream.

Navigation channel markers at Charles River Dam locks.

Pedestrian walkway (left) over Charles River Dam locks.



View of high-level double deck bridge from Charles River Dam walkway.



View downstream from south bank of Paul Revere Landing Park. Charlestown Bridge in background.

FIGURE

7

Views Of Lower Charles River

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

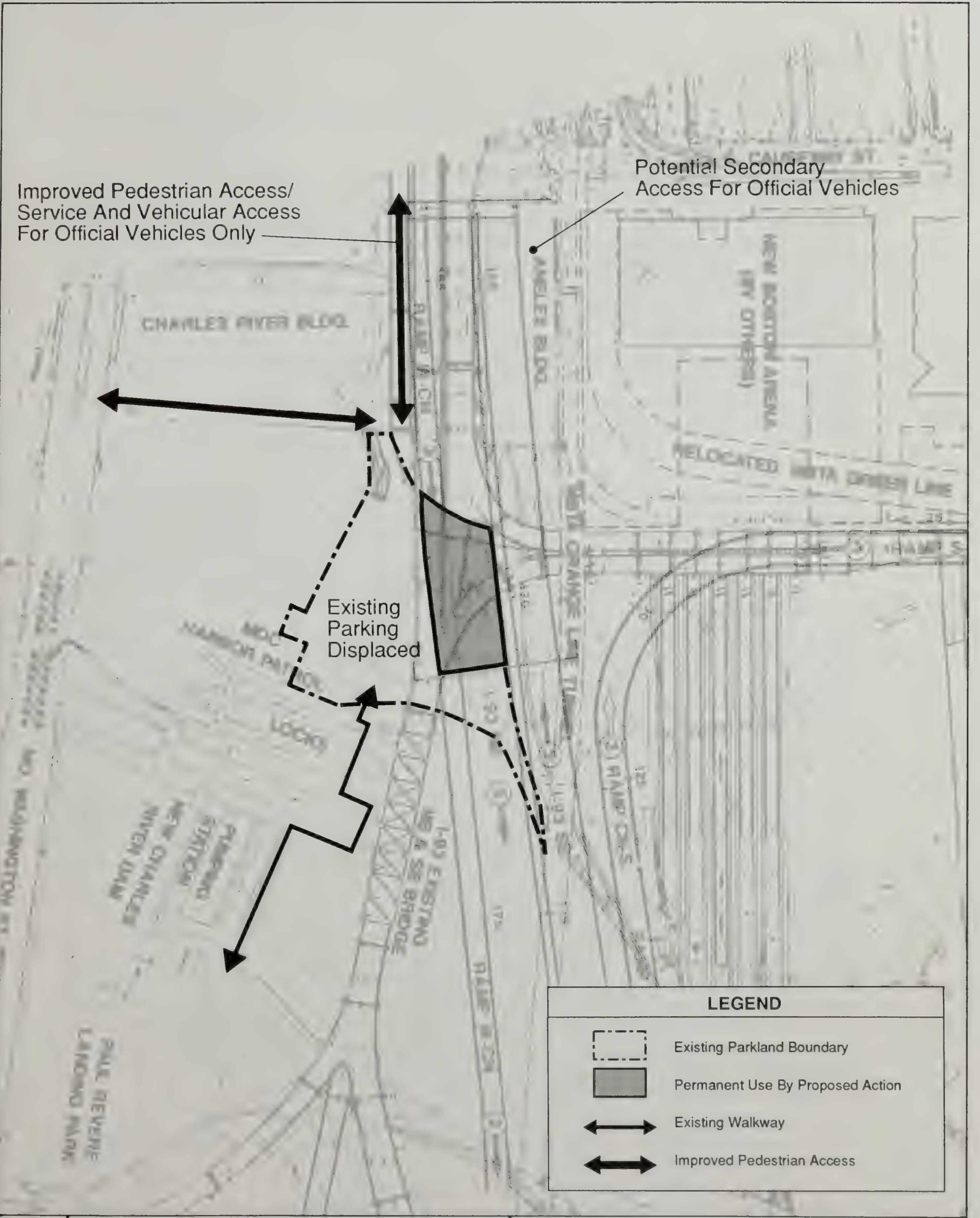

Improved Pedestrian Access/ Service And Vehicular Access For Official Vehicles Only
Potential Secondary Access For Official Vehicles
CAUSEWAY ST.
CHARLES RIVER BLDG.
RAMP 'A' CN
ANELEX BLDG.
NEW BOSTON ARENA (BY OTHERS)
RELOCATED MBTA GREEN LINE
MBTA ORANGE LINE TUNNEL
RAMP S
Existing Parking Displaced
MDC HARBOR PATROL
LOCKS
NEW CHARLES RIVER DAM
PUMPING STATION
WASHINGTON ST.
I-93 EXISTING NB & SB BRIDGE
I-93
RAMP CN-S
RAMP 'B' CN
PAUL REVERE LANDING PARK
LEGEND
Existing Parkland Boundary
Permanent Use By Proposed Action
Existing Walkway
Improved Pedestrian Access

FIGURE
8

Use Of Section 4(f) Resource (Paul Revere Landing Park, South Bank)

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CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

occupied a strip of riverfront parkland and caused realignment of the Charles River bulkhead and the path along the river.

Under the Proposed Action (Z Modified), approximately 0.69 acre of the approximately 3.0-acre park on the south bank of the Charles River will be used permanently for the eastern half of the highway retained-fill transition section (see Figure 8). The approximately 0.45-acre parkland area directly north of the abutment of this transition section, which includes approximately 250 feet of the riverside walkway, will not be taken but will be occupied temporarily during construction. In the area north of the abutment, the overhead bridge structure will be 12.5 feet above the ground surface at the abutment. This will reduce rainfall, sunlight, and natural landscaping opportunities. The intended use of the existing walkway, however, will not be impaired. This MDC-owned area is used today primarily for parking and walking, not for active recreation. Approximately 73 parking spaces will be removed permanently; however, a new 1,300-space underground garage is to be constructed by the MBTA behind Boston Garden (open July 1993), thus providing considerable additional parking adjacent to the park.

Existing air quality would be improved by the project. Future 1-hour carbon monoxide concentrations at Causeway Street near the park would decline from year 2010 baseline levels of 7.2 ppm to 6.4 ppm with scheme Z (1987 level was 12.7 ppm). Predicted 8-hour concentrations would decline from 4.7 ppm to 4.2 ppm with scheme Z (1987 level was 8.4 ppm). (See Chapter 4 of Part I of this SEIS/R.)

Increases in noise would be small. Noise levels in the south bank portion of the park would be 70 dBA (AM) and 71 dBA (PM), which are equal to or less than baseline year 2010 noise levels of 72 dBA (AM) and 71 dBA (PM) and similar to existing (1987) noise levels of 70 dBA (AM) and 69 dBA (PM). Current uses such as walking, jogging, and cycling through the area and over the dam would not be impaired by these noise levels. (See Chapter 5 of Part I of this SEIS/S.)

The remainder of the south bank park area to the east of the new transition section (approximately 1.95 acres) will be occupied temporarily by construction equipment maneuvering and equipment storage space, and will be used for access to the project's barge loading facility for marine disposal of excavated and dredged materials. The barge facility will be located in the Charles River east of the park. Pedestrian passage through this construction area (between the new dam and Causeway Street) will be provided throughout and after construction. Intermittent closures of pedestrian passage will occur, however, depending on construction operations. In addition, parking for 20 to 30 employee cars at the Charles River dam and Harbor Police facility will continue to be provided during and after construction. After construction of the new Central Artery bridges, the existing high-level truss bridge will be removed, requiring temporary use of the park for dismantling and debris removal activities. River barges will be used to remove the dismantled bridge from the area. Noise levels will increase from 69 dBA (existing) to 85 to 92 dBA during bridge removal operations which will occur over a 44-week period. This impact is unavoidable. Finally, temporary pedestrian facilities will be removed and replaced with permanent facilities and the remainder of the park will be reconstructed in response to MDC objectives.

In conclusion, the Proposed Action will acquire and permanently use 0.69 acre of publicly owned parkland on the south bank now used for parking. In addition, the Proposed Action will temporarily occupy the remainder of this part of the park (2.3 acres), now used for parking and passive recreation, for at least 4 years, and will, therefore, temporarily impair intended uses, except pedestrian and vehicular access through the area.

Scheme S Modified would permanently occupy 0.77 acre in this area, and scheme T Modified would use 0.80 acre. Both would cause permanent serious pedestrian-vehicle conflicts at the park entrance from Causeway Street owing to ramps to and from the north on I-93.

Charles River Dam Walkway: Under the Proposed Action, future air, noise, and vibration impacts on the dam will be less than those existing, since the new bridges will be farther away. In the long term, the Proposed Action will have no impact on the Charles River dam walkway, except visually. The new bridges will dominate the view upstream (to the west) because of their large size (being over 275 feet wide) and lower elevations than the present high-level bridge, which will be removed. In comparison, scheme 5A Modified would have greater impacts owing to the alignment of the northbound I-93 bridge directly above the walkway. Schemes S Modified and T Modified would have substantially the same visual impacts on the walkway as Z Modified.

Pedestrian access across the Charles River dam lock gates will be temporarily interrupted on an intermittent basis for about 1 year, for safety reasons, when the existing Central Artery high-level bridge, which is directly overhead, is dismantled and removed in 1998-99 (see Figure 8). Pedestrian access over the dam will be maintained most of the time during construction of the new Charles River bridges since they will be located approximately 95 to 140 feet upstream from the dam.

North Bank: Scheme 5A Modified would have used air rights over a corner of the existing park and would have had substantial visual impacts on the park. The Proposed Action work will not permanently or temporarily use land in this part of the park nor impair intended passive recreational uses since the new bridges across the Charles River will be constructed approximately 250 feet west of the existing park. Pedestrian access through the park will be maintained between the Charles River dam and City Square during construction. The new Charles River bridges will permanently dominate the view to the west from the park, but less so than at present because the existing bridge is practically overhead. On this basis, the visual impacts would not be so great as to substantially impair use of the park and would in fact be an improvement from the condition that predated the park. Schemes S Modified and T Modified would have similar visual impacts to Z Modified as viewed from this part of the park.

Noise, air quality, and vibration impacts, would be reduced, since the new bridges will be farther away. At City Square, near this part of the park, one-hour CO concentrations in 1987 were estimated to be 10 ppm and predicted to decline to 7.7 ppm in 2010 without the project; with scheme Z modified, this concentration would be reduced slightly to 7.0 ppm. Predicted baseline 8-hour concentrations would similarly be reduced from 5.0 to 3.9 ppm. (See Chapter 4 of Part I of this SEIS/R.)

With the project (Scheme Z), noise levels in the portion of the park near City Square would be 69 dBA (AM) and 64 dBA (PM), which are essentially equivalent to baseline year 2010 noise levels of 70 dBA (AM) and 66 dBA (PM) and equal to or less than existing noise levels of 69 dBA (AM) and 66 dBA (PM). Current uses such as walking, jogging, and cycling through the area and over the dam would not be impaired by these noise levels. (See Chapter 5 of Part I of this SEIS/R.)

Scheme 5A Modified would have crossed directly over the 4(f) replacement land committed in the CANA 4(f) statement. The Proposed Action would not permanently or temporarily use either existing parkland in this portion of Paul Revere Landing Park, nor will it affect CANA 4(f) replacement land which includes land currently under the existing I-93 bridge; however, it will affect other portions of the CANA construction area which the Department has committed to landscape in the future (see Section 2.1.8. below).

2.1.6 Avoidance Alternatives

Complete avoidance of the Paul Revere Landing Park is not possible because of the need to connect horizontally and vertically between the depressed section of the Central Artery and the CANA interchange north of the river. Thus, use of the south bank portion, while minimized by Z modified, cannot be altogether avoided by any other scheme investigated. Nor can use of the resource be reduced beyond the extent required by Z modified, which eliminates Causeway Street ramps and permits the alignment to be shifted west (away from the park) to maximum extent possible. All remaining ramps in the area are integral to the function of the project.

Further engineering work since the FEIS/R was able to solve difficulties in spanning the MBTA Orange Line rapid transit tunnel, thus permitting the modified Charles River crossing schemes to shift the bridge alignments upstream to the maximum extent possible, reducing but not eliminating use of Paul Revere Landing Park. As a result, Schemes Z Modified, S Modified, and T Modified avoid the north bank portion of the park.

As discussed in Chapter 1 of Part II of this SEIS/R, crossing the Charles River entirely in tunnel would not be feasible because vertical geometry would not make connections to Route 1 possible (at least not without complete redesign of the CANA project and reconstruction of work completed to date). Also, mainline tunnels would not connect to I-93 until a point near Sullivan Square, approximately one mile north of the project area. Substantial constructability problems would also accompany all-tunnel alternatives.

2.1.7 Overall Comparison Of Impacts Of Area North Of Causeway Street Design Options On 4(f) Parkland

Chapter 1 of Part II of this SEIS/R compares the design options developed for the Area North of Causeway Street. Since there are major differences among Z Modified, S Modified, T Modified, and 5A Modified, and since they affect the four 4(f) parklands differently, the following section has been added to this Section 4(f) Evaluation for the properties in the Area North of Causeway Street. The purpose of this section is to provide comprehensiveness and clarity and to support the discussion in Part II from the perspective of Section 4(f) requirements. Impacts are summarized in Table 2.1, below. Figure 2 is a simplified representation of each scheme.

The four design options have the same objectives: to provide connections among Route 1 north (the Tobin Bridge), Storrow Drive, Route I-93 north, and Route I-93 south (the Central Artery) while providing necessary local access. These connections require crossing the

Charles River in a manner that is acceptable environmentally and in terms of traffic safety and operations. Basic differences result from the alignment of bridges over the Charles River (travel directions side-by-side or on opposite sides of the existing I-93 bridge) and the use of tunnels under the river and/or along its banks.

Scheme 5A Modified (The FEIS/R Preferred Alternative). This scheme would include a split bridge on either side of the existing I-93 high-level bridge, an alignment chosen to simplify construction problems that have since been solved by the other schemes. The split bridge would affect Paul Revere Landing Park in three ways: a greater area of the south bank portion of the park would be occupied by structure (0.9 acre); the northbound bridge would pass over the walkway on the new Charles River dam, causing aesthetic and shadow impacts; and the northbound bridge would pass over a corner of the north bank portion of the park, using air rights and causing aesthetic and shadow impacts on the park and CANA Section 4(f) replacement land.

Scheme 5A Modified would connect the Central Artery and Storrow Drive via two tunnels on the south bank of the river. The northbound tunnel would use subsurface easements and reconfigure a strip of riverfront park in the south portion of Paul Revere Landing Park. Running in the Charles River and emerging into an open boat section before crossing the MDC Nashua Street parkland to Leverett Circle, the northbound tunnel would substantially divide this parcel, separate it from the river, disrupt potential pedestrian access along the river bank, and eliminate most of this property's value as parkland.

At Leverett Circle, 5A Modified would not reconfigure the Circle into an intersection but would enter it in such a way as to use MDC land on the Esplanade side of Storrow Drive. It would have no eastbound underpass at Leverett Circle and would not affect the eastbound Storrow Drive parkway and its highway landscaping. Access improvements to westbound Storrow Drive from the traffic circle would require a temporary easement in the Esplanade playground.

5A Modified would have no impact to the MDC parkland at the former GSA site.

For the reasons listed above and others, 5A Modified was not selected.

Scheme S Modified. This scheme would cross the Charles River on a bridge in which both travel directions would be located upstream from the existing I-93 high-level bridge. A third parallel bridge would carry a double decked Storrow Drive connector. Compared to 5A Modified, this bridge alignment would reduce the takings in the south bank portion of Paul Revere Landing Park to 0.80 acre, substantially would reduce visual impact on the walkway across the dam and the north bank portion of the park, and would avoid air rights of any portion of the north bank of the park. Local on- and off-ramps at Causeway Street would introduce a serious pedestrian-vehicular conflict with access to the park from Causeway Street.

S Modified would make the connections between the Central Artery and Storrow Drive in a manner similar to 5A Modified, except that the Artery-to-Storrow Drive tunnel would be realigned away from the Charles River. Subsurface easements would be needed in the south bank portion of Paul Revere Landing Park, but the river bank would not be modified and the MDC Nashua Street parkland would be completely avoided.

S Modified would be similar to Z Modified in its effects on Leverett Circle but would have more impacts on the Charles River Esplanade. It would include an eastbound underpass at Leverett Circle and a reconfiguration of the traffic circle into an intersection. These changes would widen a portion of eastbound Storrow Drive and use highway landscaping along its edge. Pedestrian bridges providing access to the Esplanade at Leverett Circle and Blossom Street would be reconstructed; access could be continuously maintained on at least one of the bridges. The redesign of Leverett Circle would occupy some area of landscaping currently within the Circle, remove pavement from other parts of the Circle, and permit an enlarged landscaped pedestrian area leading from the MBTA Science Park station to the Charles Street Jail and Registry of Motor Vehicles.

There would be no impact to the MDC parkland at the former GSA site.

The northbound connection from Storrow Drive to Routes 1 and I-93 north would be on a viaduct which would not affect any park property.

Apart from Section 4(f) impacts, S Modified also would have less desirable geometrics, traffic operations, land use and development impact, than Z Modified, as discussed in Chapter 1 of Part II.

Scheme T Modified. This option would use a bridge upstream of the existing I-93 high-level bridge for Route I-93 traffic, reducing impacts on Paul Revere Landing Park in a manner similar to S Modified. However, the Causeway Street off-ramp would limit the shift in bridge alignment, and this scheme would use 0.77 acre of parkland, more than Z Modified. Connections between Storrow Drive and the Tobin Bridge would be through a tunnel under the Charles River, making the I-93 bridge narrower than for S Modified and Z Modified, somewhat reducing visual impacts on the walkway across the dam and the north bank portion of the Paul Revere Landing Park. As in S Modified, on- and off-ramps at Causeway Street would not use parkland but would introduce a serious pedestrian-vehicular conflict with access to the park from Causeway Street. Scheme T Modified would require a temporary taking for construction traffic, plus the location of a vent building adjacent to the new extended Esplanade planned near Leverett Circle.

The tunnel under the Charles River in scheme T Modified would pass under the MDC Nashua Street parkland, requiring permanent subsurface easements and using all of the parcel for the entire construction period. A construction easement also would be required on the edge of the Esplanade playground to detour traffic during construction of the connection to westbound Storrow Drive.

Under T Modified, the MDC parkland at the former GSA site may be affected during construction by a graving basin needed to fabricate the tunnel sections. This construction staging area would be excavated to below the depth of the river bottom and might occupy part of the former GSA site. Apart from the adjacent North Point area of Cambridge, which may not be sufficient in area, the former GSA site is the only vacant site available for the graving basin. In any case, dredging along the GSA side and reconstruction of the bulkhead might be required.

Apart from Section 4(f) impacts, T Modified would have major constructibility problems, construction period water quality impacts, and less desirable traffic operations on mainline segments and intersections than Z Modified, as discussed in Chapter 1 of Part II.

Table 2.1

SECTION 4(f) PARKLAND IMPACT SUMMARY AREA NORTH OF CAUSEWAY STREET

4(f) Property	5A Modified	S Modified	T Modified	Z Modified
Paul Revere Landing Park	Uses 0.9 acre south, plus 0.7 acre of air rights over south, dam, and north portions. Causeway ramps interfere with pedestrian access.	Uses 0.80 acre, south, plus 0.31 acre of air rights; displaces 73 parking spaces. No land used north. Causeway ramps interfere with pedestrian access.	Uses 0.77 acre south, plus 0.30 acre of air rights; displaces 73 parking spaces. Causeway ramps interfere with pedestrian access.	Uses 0.69 acre south, plus 0.29 acre of air rights; displaces 73 parking spaces. No land used north. No pedestrian conflict.
	Substantial temporary use of north bank, reshapes south bank, limits north park expansion.	Allows greater CANA expansion of uninterrupted park.	Allows greater CANA expansion of uninterrupted park.	Allows greater CANA expansion of uninterrupted park.
	Major shadow impact and air rights on walkway over dam.	No shadow or air rights over walkway.	No shadow or air rights over walkway.	No shadow or air rights over walkway.
	Smaller bridges, but dominates area from MBTA bridge to dam.	Large visual impact, concentrated near MBTA bridge.	Medium/large visual impact, concentrated near MBTA bridge.	Largest visual impact, concentrated near MBTA bridge.
	Vent facilities at Lovejoy Wharf.	No vent facilities in area.	No vent facilities in area.	No vent facilities in area.

Table 2.1 (Cont.)

SECTION 4(f) PARKLAND IMPACT SUMMARY AREA NORTH OF CAUSEWAY STREET

4(f) Property	5A Modified	S Modified	T Modified	Z Modified
Leverett Circle/ Storrow Drive/ Esplanade	Temporary detour and permanent use of 0.2 acres in playground land. Highway landscaping not permanently affected. Greater air quality impact than Z Modified.	Uses 0.5 acre of highway landscaping; removes 0.2 acre of pavement; net use 0.3 acre, but adds 0.27 acre of new landscaping. Greater air quality impact than Z Modified.	Uses 0.64 acre of highway landscaping, removes 0.06 acre of pavement; net use 0.58 acre, but adds 0.18 acre of new landscaping. Greater air quality impact than Z Modified.	Uses 0.5 acre of highway landscaping; removes 0.2 acre of pavement; net use 0.3 acre, but adds 0.27 acre of new landscaping.
		No impact on playground.	Temporary detour in playground land.	No impact on playground or on Esplanade walkways.
Nashua Street/ Esplanade Park Extension	Essentially precluded by ramp in the Charles River.	No impact.	Subsurface easement.	No impact.
			Substantial construction impacts delay park.	
GSA Site	No impact.	No impact.	Possible construction impact from graving basin.	No impact.

Source: Bechtel/Parsons Brinckerhoff

Scheme Z Modified. Scheme Z Modified would use a bridge alignment similar to S Modified and T Modified, but would reduce takings in the south bank of Paul Revere Landing Park to 0.69 acre, which is less than S Modified and T Modified. Because it would have no on or off-ramps at Causeway Street, only Z Modified would avoid the serious pedestrian-vehicle conflict at the entrance to this park. Unlike the other schemes, Z Modified would make all connections to Storrow Drive by viaducts; in order to provide more acceptable weaving distances than the other schemes, traffic in Z Modified would make connections from the Central Artery to Storrow Drive via the ramps north of the river. The visual impacts of these bridges would be marginally greater than with S Modified and T Modified as viewed from the walkway across the dam and the north bank portions of Paul Revere Landing Park but, as with them, impacts would be concentrated near the existing MBTA railroad bridge, and the north bank portion of Paul Revere Landing Park could be expanded beyond the existing I-93 bridge (which was the limit of the mitigation/replacement land committed in the CANA 4(f) statement).

Scheme Z Modified would have no tunnels between the Central Artery and Storrow Drive. There would be no impact on the MDC Nashua Street parkland.

At Leverett Circle, there would be an eastbound Storrow Drive underpass and a reconfiguration of the traffic circle into an intersection essentially the same as with Scheme S Modified. These changes would widen a portion of eastbound Storrow Drive and use highway landscaping along its edge (0.3 acre), but would not require any permanent or temporary use of land in the Esplanade playground as 5A Modified, or T Modified would. Pedestrian bridges providing access to the Esplanade at Leverett Circle and Blossom Street would be reconstructed; access could be continuously maintained on at least one of the bridges. The redesign of Leverett Circle would occupy 0.25 acre of landscaping currently within the Circle, remove pavement from other parts of it (0.19 acre), and permit an enlarged landscaped pedestrian area leading from the MBTA Science Park station to the Charles Street Jail and Registry of Motor Vehicles, adding 0.27 acre of new land to the MDC property.

There would be no impact to the MDC parkland at the former GSA site.

In summary, Z Modified has the least 4(f) impacts of the four options studied in detail. (As discussed in Chapter 1 of Part II of this SEIS, other reasons for selection of Z modified include best traffic operations on critical segments, best constructability, and fewest takings.)

2.1.8 Measures To Minimize Harm To 4(f) Parkland Resources In The Area North Of Causeway Street

There are several purposes of 4(f) mitigation in the Area North of Causeway Street. First, mitigation is intended to minimize direct harm to the 4(f) parkland properties described in this chapter and to provide for their continued functioning as parkland both temporarily and permanently. Second, because the Charles River crossing will be a visually dominant element throughout the area, despite the relatively small extent of 4(f) parkland actually used, the Department seeks to take advantage of all opportunities created by the project to further and enhance parkland development on both sides of the river, integrating the project with future parkland and existing 4(f) land and providing usable pedestrian access routes that join existing and future parkland in the area. Because the Artery/Tunnel Project affects the area in numerous locations, it is appropriate for the Department to work with the MDC and the Cities of Boston and Cambridge toward an overall plan for the area which will integrate and coordinate mitigating measures with park development to best advantage and in a mutually consistent manner.

A third purpose is to integrate the Proposed Action effectively with CANA project mitigation on the north bank of the Charles River adjacent to the existing Paul Revere Landing Park. This will require modification of the existing specific design concept for the land which assumes no Charles River crossing improvement of any kind, but the full intent of those mitigation commitments will be honored by the Department, and the parkland development of the area will be completed as part of the Proposed Action.

The parkland mitigation measures described below are intended to meet planning and design objectives of the MDC and other agencies and interest groups for park development of the Lower Charles River. The primary objective is to extend the Esplanade along both banks of the river, filling an important gap in the MDC's Charles River park system. The Artery/Tunnel Project provides the opportunity to complete, or nearly complete, pedestrian/bicycle and landscape connections between important park resources upstream of the Museum of Science dam and downstream of the North Washington Street bridge: that is, on the north bank to connect the Lechmere Canal Park/Esplanade through the project area to the Charlestown Navy Yard, and on the south bank to provide all but the final connection across the railroad tracks between the Esplanade and the MDC's and City of Boston North End parks (see Figure 9).

This system of improvements is intended to facilitate completion of the MDC parkland system immediately after construction of the project, to treat the individual parkland components as a system, and to give a high priority to pedestrian and bicycle access around the Charles River and connections to it from the Esplanade, Cambridge waterfront, Charlestown, North Station area, and the Boston Harborwalk.

The planning concept for the area is to create a park environment in the Lower Charles River which is the important transition zone between the Esplanade on the west and Boston Harbor on the east. While this area would call on some of those areas' characteristics, it also would have its own unique character. This would come mainly from the relatively small-scale, enclosed and urban nature of the space, and from the heavily transportation-oriented land uses through and bordering much of the area.

While this area will be a distinct zone in the entire Charles River Park system, it also will be composed of a number of park nodes and landscaped connections, each with its own character and treatment. The major nodes occur at either end of the zone: the former GSA site and the expanded Paul Revere Landing Park on the north bank; and the Nashua Street parkland and Lovejoy Wharf on the south bank.

In view of the historic uses in this area, an industrial and transportation theme might be considered as a unifying approach. It can be expected that the area will remain to some degree unlike any other along the Charles River. The area between the dams can act as an appropriate end to the Esplanade corridor by giving its terminal area a single image, common to both banks. Granite walls, pathways, and railings alongside the river can establish a strong linear dimension. Forming the transition between the Esplanade and Boston Harbor, some type of hard-edged urban treatment of both river edges should be carried downstream to the new dam. Identifying features from other areas along the Charles River could be integrated that suggest, perhaps, the original concept of the Esplanade. These features could include interpretive areas, monuments of dedication, open plazas, or open lawn areas. All in all, however, the theme of industry, transportation, and manmade environment should be portrayed, making the area a special distinguishable element in the Esplanade network.

Relationship To CANA Project Commitments. The Department has supported the objectives of the MDC which enrich the context of the 4(f) properties in the area and strengthen pedestrian access to and through them. This commitment to MDC goals has been evident in the mitigation commitments of the CANA project documents and the Artery/Tunnel Project FEIS/R. It is continued here. Common to those measures to minimize harm are efforts to refine the design of highway improvements to reduce 4(f) impacts to the extent possible and the commitment to support the MDC's areawide goals by assisting with the acquisition and development of parkland and the improvement for park use of Department land not needed for highway improvements. These measures affect three areas: restoration of the existing park; CANA 4(f) mitigation and replacement land which extends westward to land under the existing I-93 viaduct; and land to the north and west of these areas.

Following the Artery/Tunnel FEIS/R and finalization CANA 4(f) commitments, further CANA project coordination with the MDC took place in the context of application for a Chapter 91 license for use of former tidelands by CANA. The Department's assistance with the MDC's future park acquisition plans was identified as a means to mitigate the nonwater-dependent use of tidelands by CANA. As a result, the Department agreed to go as far as possible toward satisfying the MDC's goals for future parkland acquisition on land available after completion of the highway projects. Specifically, continuous pedestrian access is to be provided along the river through Department land and over the MBTA commuter rail tracks. Land under and around the bridges and elevated loop ramps is to be conveyed to the MDC upon completion of both highway projects, some segments of which will be constructed concurrently.

In Z Modified and other design options, continuous pedestrian access can be provided along the river as envisioned in the CANA Chapter 91 conditions. Land in the CANA construction area under and between the highway structures would be improved to different degrees by schemes 5A Modified, S Modified, T Modified, and Z Modified, and these schemes differ in their future aesthetic impacts on landscape improvements in this area. These impacts are described in detail Chapter 1 of Part II of this SEIS/R, and summarized above in Section 2.1.7. The effects on this land can be summarized as follows. Z Modified permits less improvement in the CANA construction area than the other schemes, of which 5A Modified has the least impact, followed by T Modified and S Modified; however, schemes S Modified, Z Modified, and T Modified all permit more uninterrupted expansion of the existing park beyond the CANA 4(f) replacement land than 5A Modified.

As noted above, Z Modified also preserves pedestrian access to the waterfront along the south bank of the river and at the existing Paul Revere Landing Park, locations where the waterfront is expected to be particularly usable by large numbers of people. This pedestrian access to the river is served by improvements in access from the MBTA's Science Park and North Stations, and is part of a balanced transportation system through the project

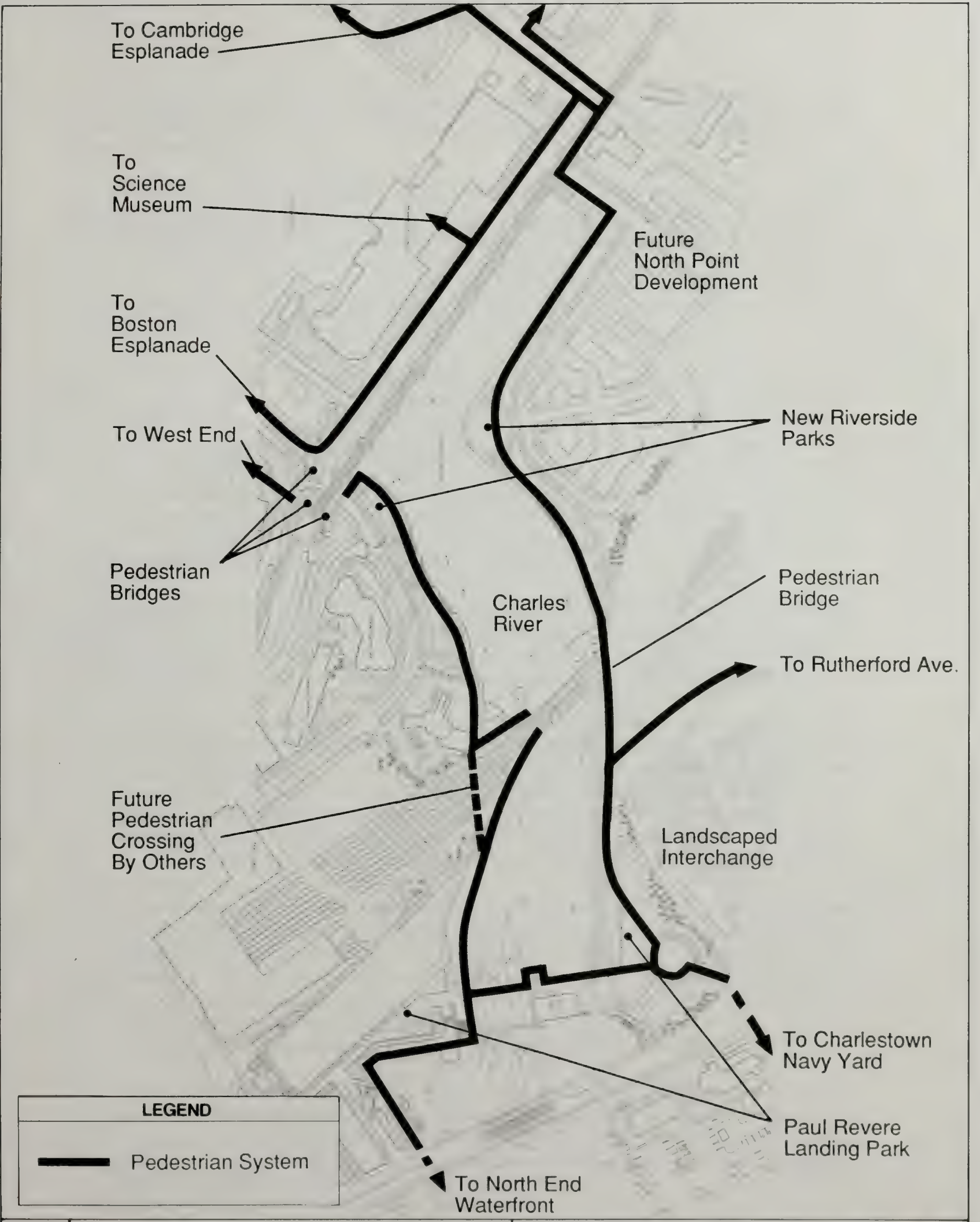

FIGURE 9

General Parkland Development Objectives, Area North Of Causeway Street

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area. Lovejoy Wharf, paths from Causeway Street, the pedestrian bridge over the MBTA commuter railroad tracks on the north bank, and new paths to Science Park station are major links in this system.

Proposed Postconstruction Mitigation Measures. Figure 9 shows the general parkland development objectives in the Lower Charles River area. Figure 10 shows the location of proposed mitigation measures, and Figure 11 shows the illustrative parkland development concept for the Lower Charles River. These mitigation measures are extensive and are intended to lessen the overall visual impact of the large-scale structures in this developing parkland area, even though the Proposed Action will permanently use only a relatively small area of Section 4(f) resources.

As a matter of policy, the Department will construct park improvements on land owned by the MDC or to be transferred to the MDC in the future for parkland development on the Lower Charles River. Because of the extent of the improvements proposed, the Department will work with the MDC to prepare a park development plan for the area in consultation with the Cities of Boston and Cambridge and other agencies and interest groups. For land not already publicly owned, the Department will assist the MDC in acquiring land or easements and will work cooperatively to provide design and construction services. The Department will continue to work with the MDC, the Cities of Cambridge and Boston, and other interests to achieve the overall improvement of the Lower Charles River area.

The following is a list of specific mitigation measures that the Department is committed to implement to mitigate the permanent and temporary takings and adverse visual impacts of the Proposed Action in the Lower Charles River. (Figure 10 shows the location of specific proposed mitigation measures in the area keyed to the numbers and letters listed below.)

- Paul Revere Landing Park (1): The south bank portion of the Paul Revere Landing Park not permanently used by the Proposed Action will be restored after construction. The minor reconfiguration that will occur in this area will maintain all previous park functions and enhance them, as 73 parking spaces will be displaced (see Figure 12). On the north bank, the park will be expanded north and west to the CANA ramps and new bridges, completely relandscaped as a major element in the riverfront park system, and connected by landscaped walkways through the CANA loop area and to Charlestown.

- CANA Chapter 91 Waterways License, Special Conditions (2): The Chapter 91 conditions include: (a) landscaping and maintenance of highway infield areas; (b) landscaping, including pedestrian/bicycle path along the north bank of the Charles River, and transfer to the MDC; (c) construction of landscaped pedestrian path from Rutherford Avenue to the Charles River and transfer to the MDC; (d) construction of a pedestrian bridge over the MBTA commuter rail tracks and transfer to the MDC; and (e) reconstruction of the Millers River, landscaping, and transfer to the MDC.

  Although the details of Chapter 91 License conditions will require revision to accommodate replacement of the existing I-93 high-level bridge, the Department remains committed to the basic purpose of the CANA conditions. The Department will implement the CANA Chapter 91 mitigation measures listed in the preceding paragraph, as revised to be compatible with the Proposed Action.

This may include relocation of the Millers River (see Figure 13) to increase sunlight and, potentially, to provide a boat landing ramp. The latter would require removal of the existing conduits at the Charles River bank to allow boats to pass through. Parking areas for this use also would be provided east of the Miller River under the ramps. This would satisfy a longstanding objective of the MDC to provide a public boat landing. Alternatively, the Millers River could be relocated east of I-93, passing through the expanded Paul Revere Landing Park as a new feature of the landscape.

- o Viaduct Design (3): The structural design, placement of columns, lighting, and architectural treatment of perimeter facade, underside, and columns will be done so as to be as compatible as possible with the park improvements, and to present an acceptable appearance to abutting uses in the North Point area of Cambridge and the Charlestown area bordering the ramps.

- o Lovejoy Wharf Walkway and Ferry Terminal (4): A pedestrian walkway and a commuter ferry landing facility will be constructed on a rebuilt Lovejoy Wharf (see Figure 12).

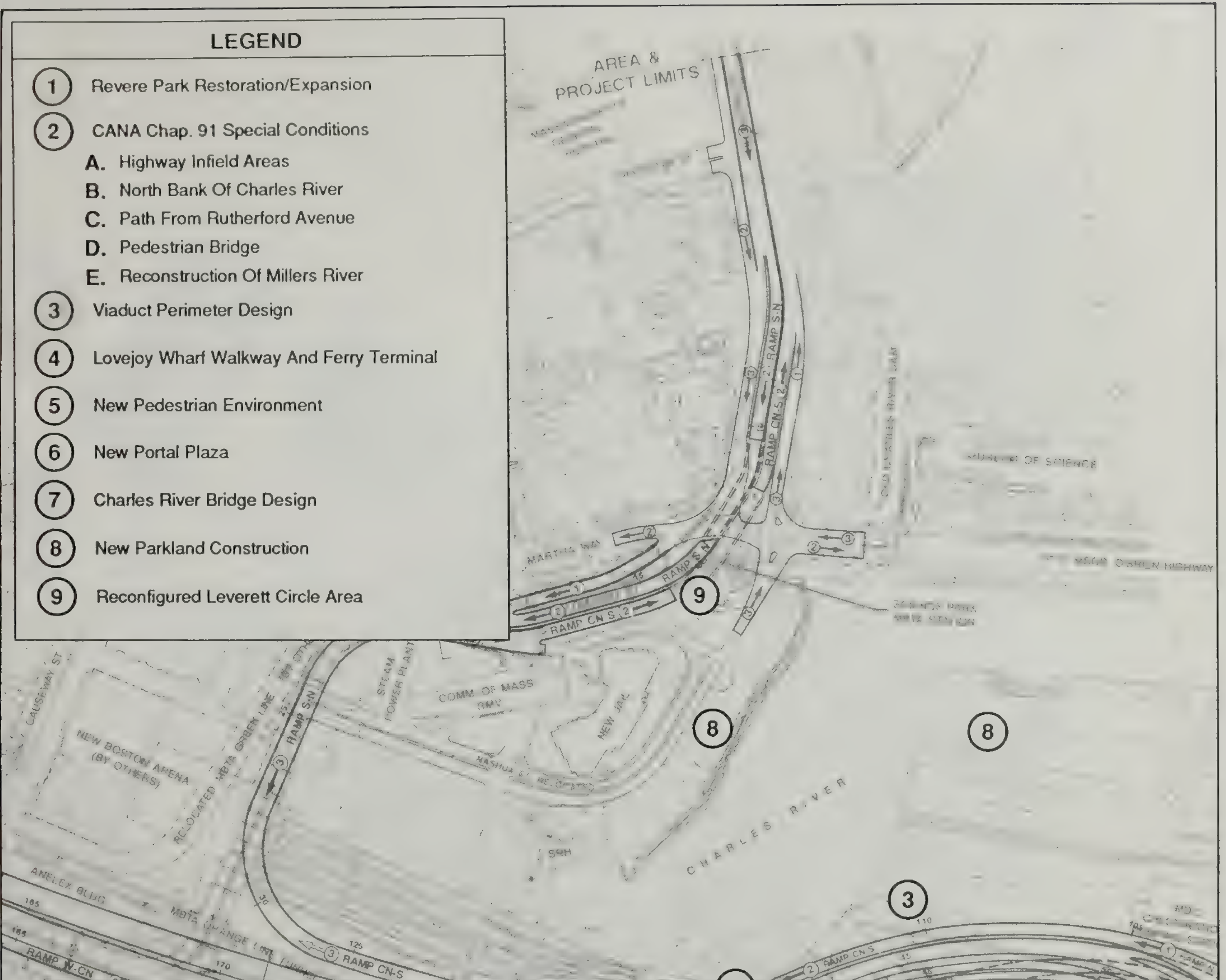
- o New Pedestrian Environment (5): An attractive pedestrian environment will be developed on the east and north sides of the Charles River bridge transition section and abutment between Paul Revere Landing Park (south bank) and Causeway Street. Access on the west side of the bridge abutment will be determined in coordination with developers of the new Boston Garden.

- o New Portal Plaza (6): A small urban plaza marking the entrance to Paul Revere Landing Park will be constructed as a part of the Proposed Action above the Causeway Street portal of the I-93 tunnel.

- o Charles River Bridge Design (7): Bridge design is a major factor in the overall aesthetics of the area surrounding the Lower Charles River, which the FEIS/R identified as a potential measure to mitigate visual impacts on 4(f) properties. The Proposed Action currently assumes that the Charles River crossing will be on three closely spaced bridges with 17 supporting columns (see Figure 14). Alternative Charles River bridge design features will continue to be considered, including haunched girder and cable-stayed structures. The haunched girder type permits a more aesthetic design using a complex of four bridges on eight columns. The cable-stayed bridge also has four bridges and eight supports, two of which are major towers; this bridge type is the most dramatic and potentially beautiful and creates a major gateway to the City, but is substantially more costly (see Figures 15 and 16).

  The major alternative bridge types would open up sight lines across and along the river at ground level and would present more aesthetically pleasing forms, which would continue to be dominant visual elements. Both engineering and aesthetic analyses are needed, together with agency coordination and public discussion in order to determine the technical and cost feasibility and desirability of alternative bridge types.

- o Design and Construction of New Parkland (8): The Department will pay for the preparation of an overall master plan and design and contract documents for two major



LEGEND

① Revere Park Restoration/Expansion

② CANA Chap. 91 Special Conditions

- A. Highway Infield Areas
- B. North Bank Of Charles River
- C. Path From Rutherford Avenue
- D. Pedestrian Bridge
- E. Reconstruction Of Millers River

③ Viaduct Perimeter Design

④ Lovejoy Wharf Walkway And Ferry Terminal

⑤ New Pedestrian Environment

⑥ New Portal Plaza

⑦ Charles River Bridge Design

⑧ New Parkland Construction

⑨ Reconfigured Leverett Circle Area

FIGURE 10

Location Of Proposed Mitigation Measures, Area North Of Causeway Street

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

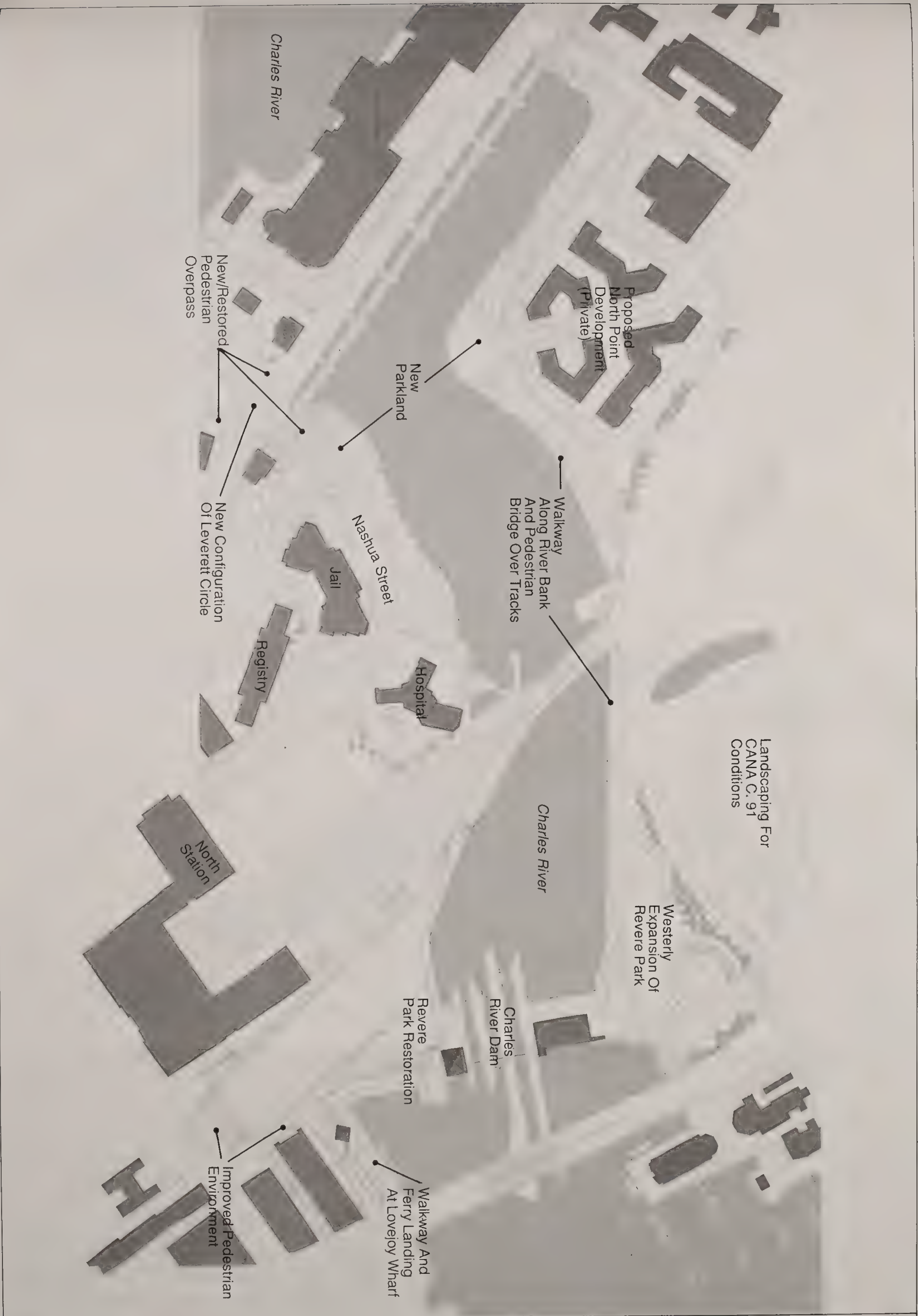
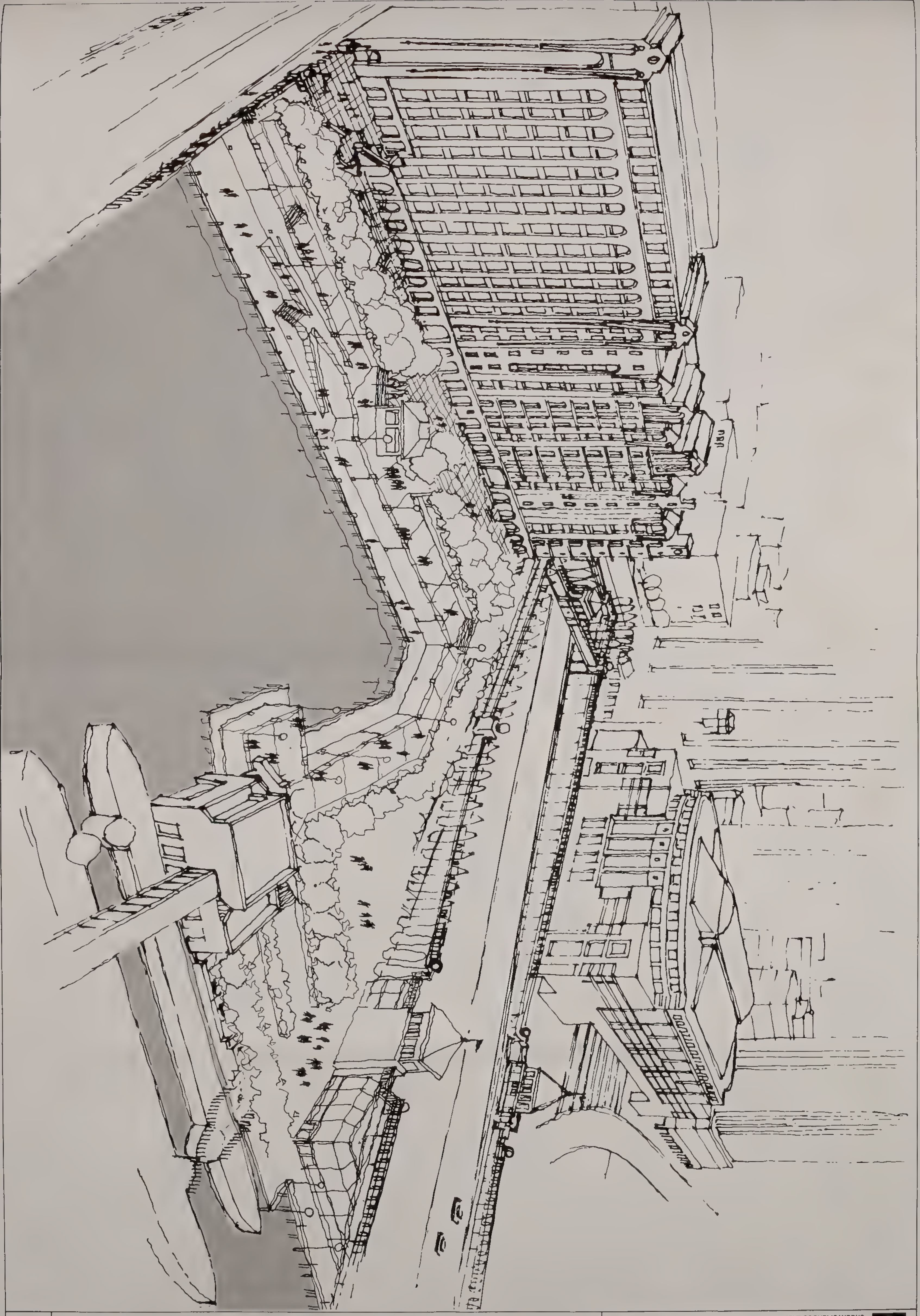

Charles River
New/Restored Pedestrian Overpass
New Configuration Of Leverett Circle
Registry
Jail
Nashua Street
New Parkland
Hospital
North Station
Proposed North Point Development (Private)
Walkway Along River Bank And Pedestrian Bridge Over Tracks
Charles River
Landscaping For CANA C. 91 Conditions
Westerly Expansion Of Revere Park
Charles River Dam
Revere Park Restoration
Improved Pedestrian Environment
Walkway And Ferry Landing At Lovejoy Wharf

FIGURE 11

Illustrative Parkland Development Concept, Area North Of Causeway Street

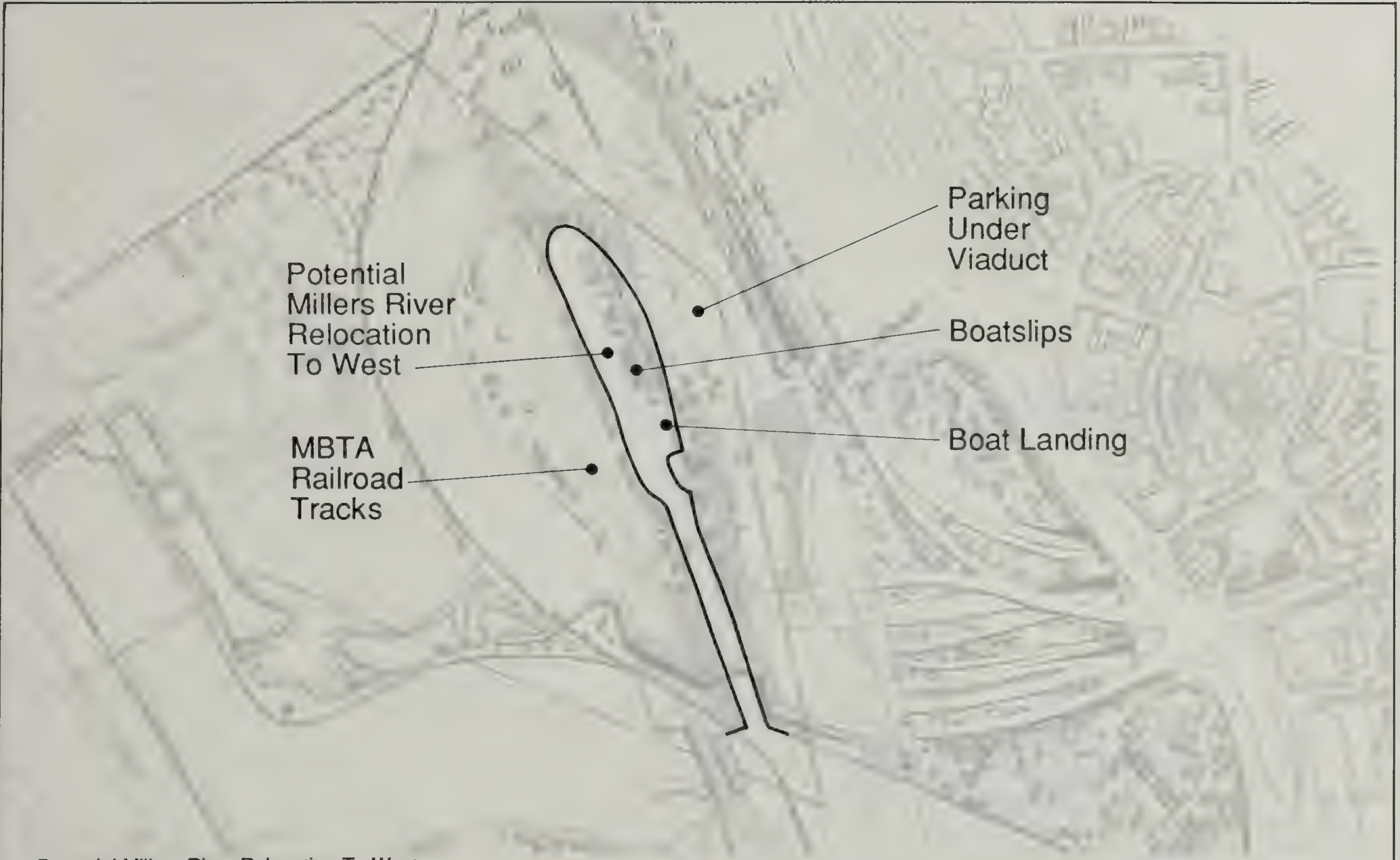
THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R



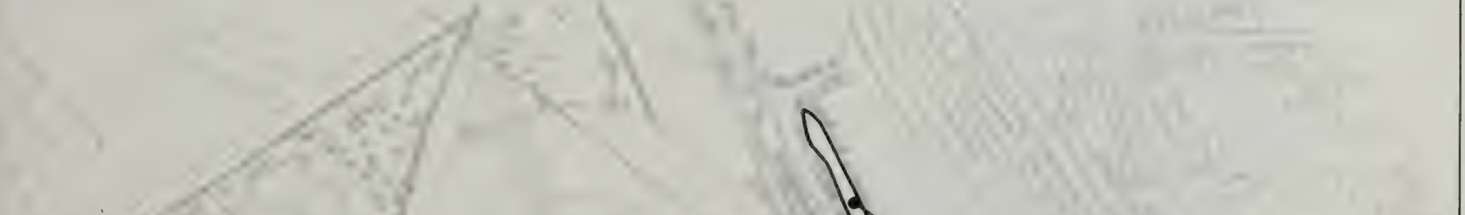
FIGURE

12 Illustrative Development Concept At Revere Park (South Bank) And Lovejoy Wharf

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R



Potential Millers River Relocation To West

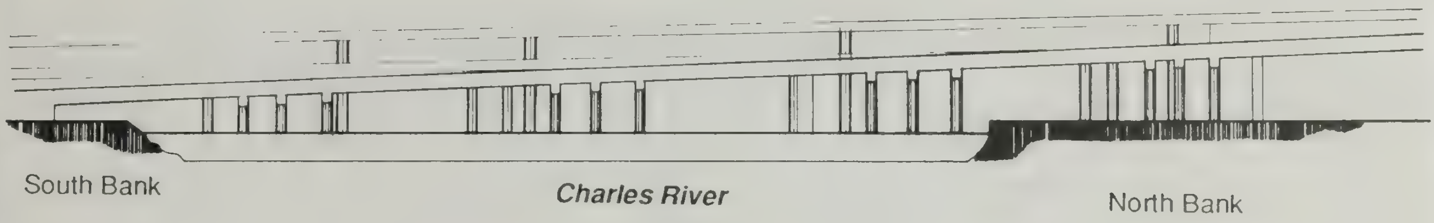


Potential Millers River Relocation To East

FIGURE
13

Illustrative Millers River Relocation Development Concepts

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R



Scheme Z Proposed Action

Elevation

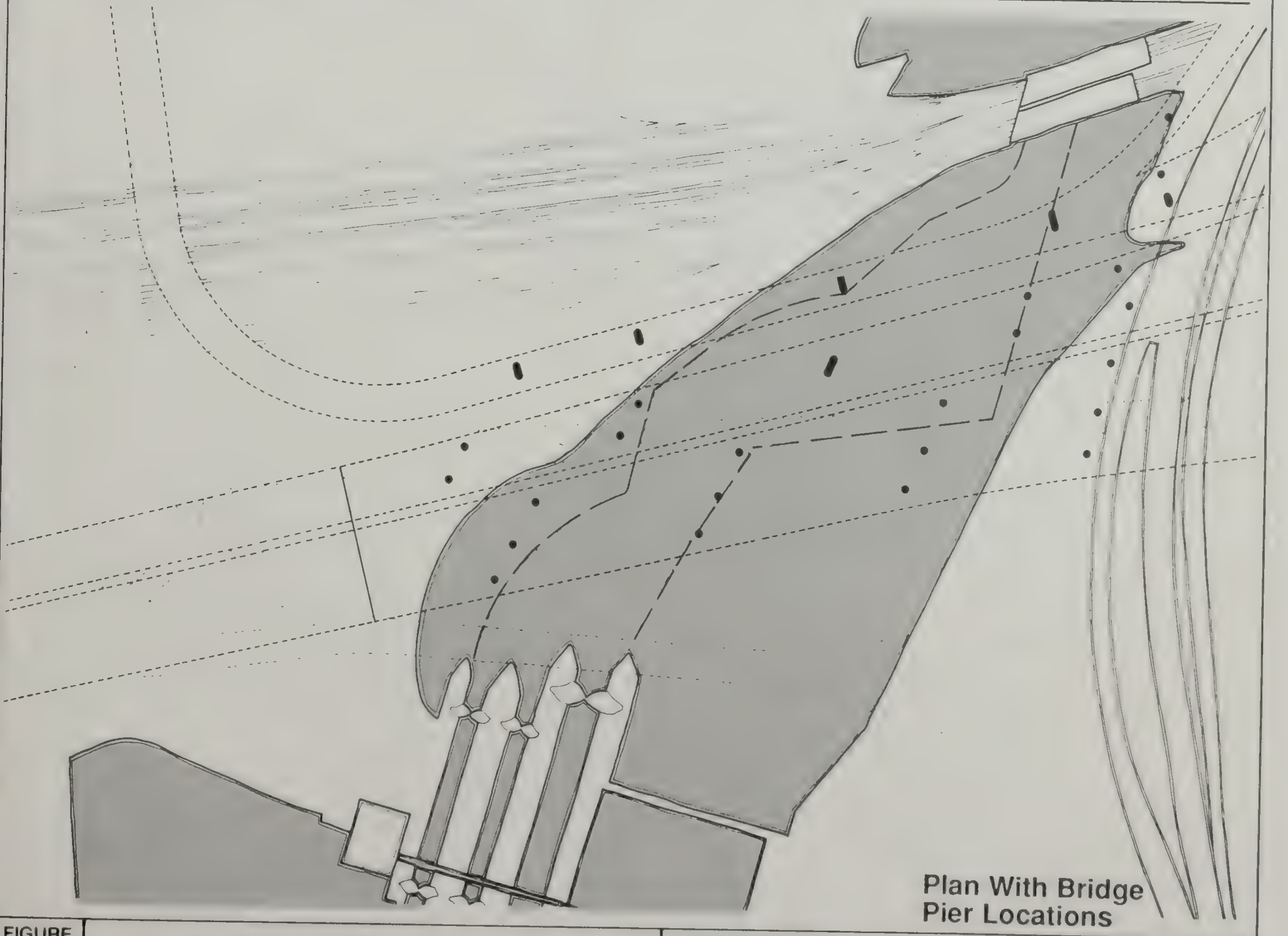
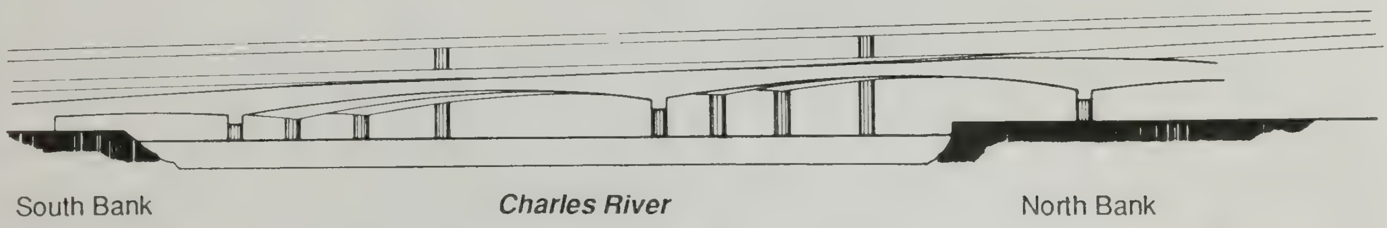


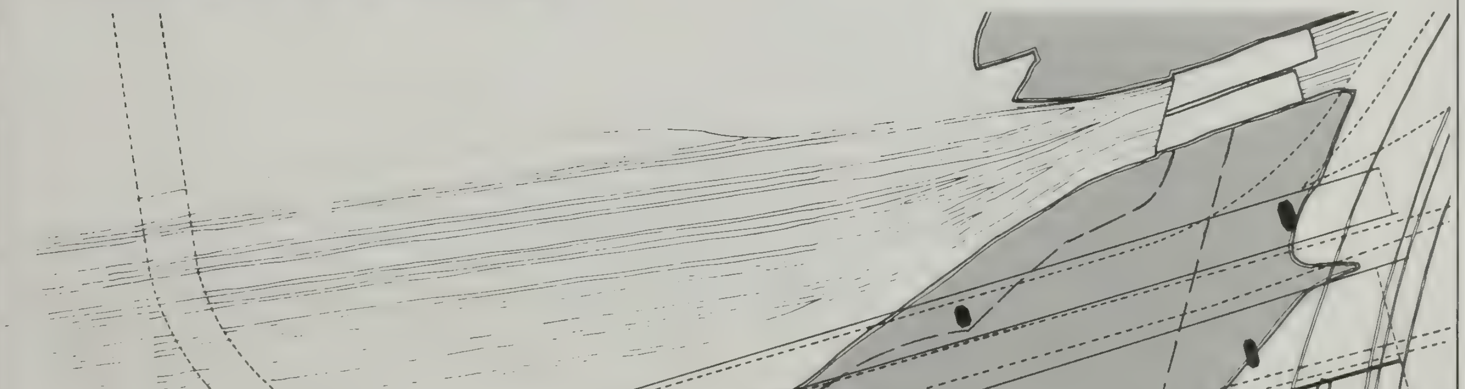
FIGURE 14

Illustrative View Of Charles River Bridges, Proposed Action

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R



Haunched Girder Bridge (Option 8) **Elevation**

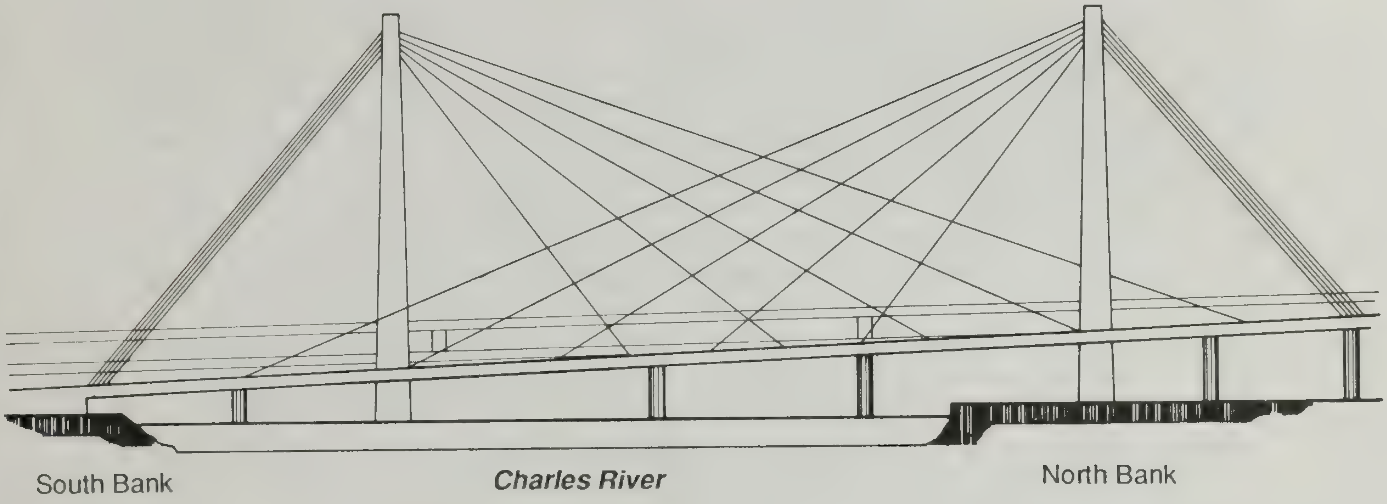


Plan With Bridge Pier Locations

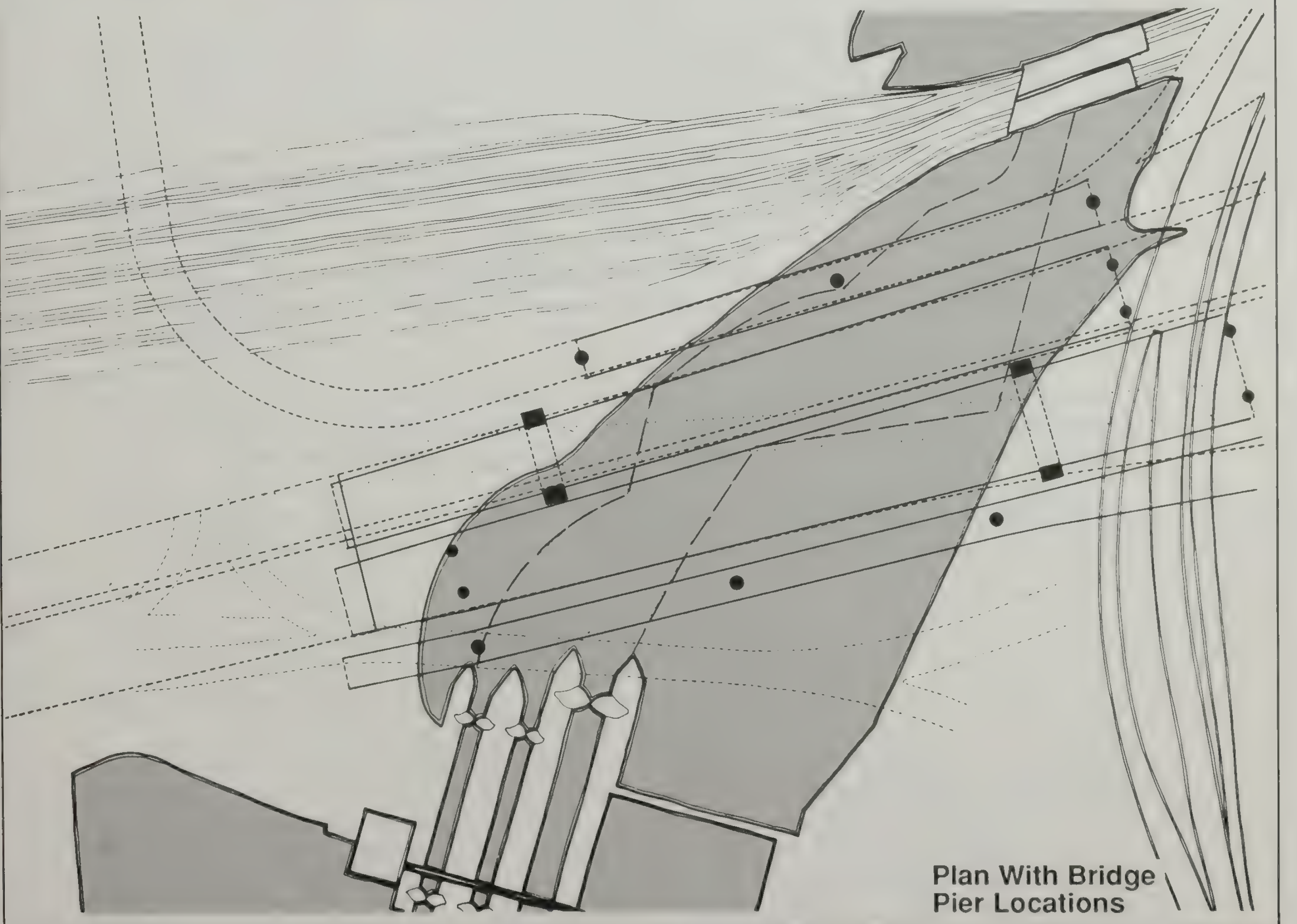
FIGURE
15

Illustrative View Of Alternative Charles River Bridge Structural Types: Option 8

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R



Cable Stayed Bridge (Option 9) **Elevation**



Plan With Bridge Pier Locations

FIGURE 16

Illustrative View Of Alternative Charles River Bridge Structural Types: Option 9

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

properties essential to the completion of the MDC park system and for the park development of these properties. These are: (a) the Nashua Street parkland which provides a major opportunity for heavy public use of an extended Esplanade; and (b) the former GSA site, which will be a major park node on the north bank of the river serving new development in Cambridge and connecting to Paul Revere Landing Park via the improvements in the CANA Chapter 91 area. Land or easements along the North Point development area, which completes the connection on the north side of the river, may be obtained through the development process, and the Department will provide assistance with park improvements on easements secured by the MDC.

- Reconfigured Leverett Circle Area (9): Improvements to Leverett Circle will be provided as a part of the Proposed Action, including landscaping of a larger reconfigured parkland area as well as reconstruction of pedestrian overpasses. Landscaping in the area will be compatible with the Charles River Esplanade ambience and will create an attractive visual terminus to Storrow Drive (see Figure 17).

Proposed Construction Period Mitigation. The following measures are proposed to mitigate the construction period impacts of the project on the 4(f) properties in this area:

- Pedestrian access will be maintained from Causeway Street to the walkway on the new Charles River dam and through the northern portion of Paul Revere Landing Park, except for brief interruptions required for the safety of pedestrians during hazardous construction procedures.

- MDC employee parking in Paul Revere Landing Park will be maintained on-site during construction.

- The existing Paul Revere Landing Park will be cleared of construction materials and restored to public use as early as possible even prior to completion of construction in the area.

- Replacement of pedestrian bridges over Storrow Drive at Blossom Street and Leverett Circle will be staged so that at least one bridge is always open to public access. The replacement of these bridges will be accomplished in the minimum feasible time.

- Construction of park improvements at the Nashua Street and GSA sites will take place in an early Project phase to offset construction period development at Paul Revere Landing Park.

2.2 EAST BOSTON MEMORIAL STADIUM PARK

2.2.1 Proposed Action

The Third Harbor Tunnel (I-90) in East Boston will connect directly with the Logan Airport roadway system and with Route 1A to and from the north. The two-lane eastbound and westbound roadway will continue in tunnel and will emerge from a portal in the vicinity of the existing Eastern Airlines Reservation Center. The toll collection facilities for the Third Harbor Tunnel will be located in this area. It will then ascend onto a viaduct connector along the north edge of the East Boston Memorial Stadium Park to merge with relocated Route 1A northbound, just before the existing Neptune Road off-ramp. (The Proposed Action of the Artery/Tunnel Project is described in Chapter 2 of the SEIS/R, Part I. The specific segment of the Proposed Action which affects the parkland in East Boston is described in Section 2.2.6, East Boston/Logan Airport Area.)

From Route 1A southbound, traffic bound for the Third Harbor Tunnel will diverge to the left, and traffic continuing on Route 1A as well as traffic bound for the airport will diverge to the right. Third Harbor Tunnel traffic will ascend onto viaduct (on the northbound viaduct adjacent to the park), cross over airport roadways, and descend into tunnel, adjacent to the existing Eastern Airlines Reservations Center. Airport-bound traffic will diverge to the left from Route 1A southbound, ascend onto the viaduct, and merge with airport-bound traffic from Route 1A northbound. This airport-bound traffic from Route 1A northbound/Callahan Tunnel will exit onto a new ramp that will pass west and north of the existing Airport Blue Line station.

A new airport bus roadway around the MBTA Blue Line station will cross the tracks with a full grade separation at the tunnel portal. From the MBTA tunnel portal to the station, this surface road will run along Orleans Street between the park and the station. Access to the park will continue as at present. The airport access road system from Route 1A will be along the alignment of the existing airport egress road adjacent to the East Boston Memorial Stadium Park. The existing airport access road and connecting ramps will be removed at the completion of construction.

Traffic will emerge from the airport on a relocated egress road adjacent and parallel to the arrivals level of the access road. Traffic will either diverge to the left, utilize an at-grade loop ramp, and join I-90 westbound, or bear right and connect to Route 1A northbound and southbound via new below-grade ramp connections.

2.2.2 Description Of The Section 4(f) Property

The East Boston Memorial Stadium Park is 17.67 acres in size. It has an elongated shape, with a northwest-to-southeast orientation, and is located between the existing inbound and outbound airport access roads east of Route 1A. The area includes a parcel of 50,400 square feet located southwest of the inbound airport roadway (see Figures 18 through 20). The latter parcel was augmented by approximately 26,000 square feet of adjacent land leased from Massport. Access to the park is by means of easements over land owned by the Department for Route 1A ramps to the airport.

The facilities include a softball field, baseball field, and 4,900-seat football stadium, all of which have floodlighting for evening use. The stadium building contains offices, shower rooms, a first aid station, locker facilities, and a maintenance depot for the owner, the Boston Parks and Recreation Department. A track, basketball courts, and a tot-lot with wading pool, swings, slide, and jungle gym also are provided. Tennis courts lie at the southeastern end of the field. The parcel southwest of the inbound roadway is paved and was once demarcated as a parking lot but is not used for any purpose as presently configured, and is closed to the public.

All facilities in the stadium complex are heavily used. It is the only East Boston park with a single-use football field, and one of only four East Boston parks with floodlights.

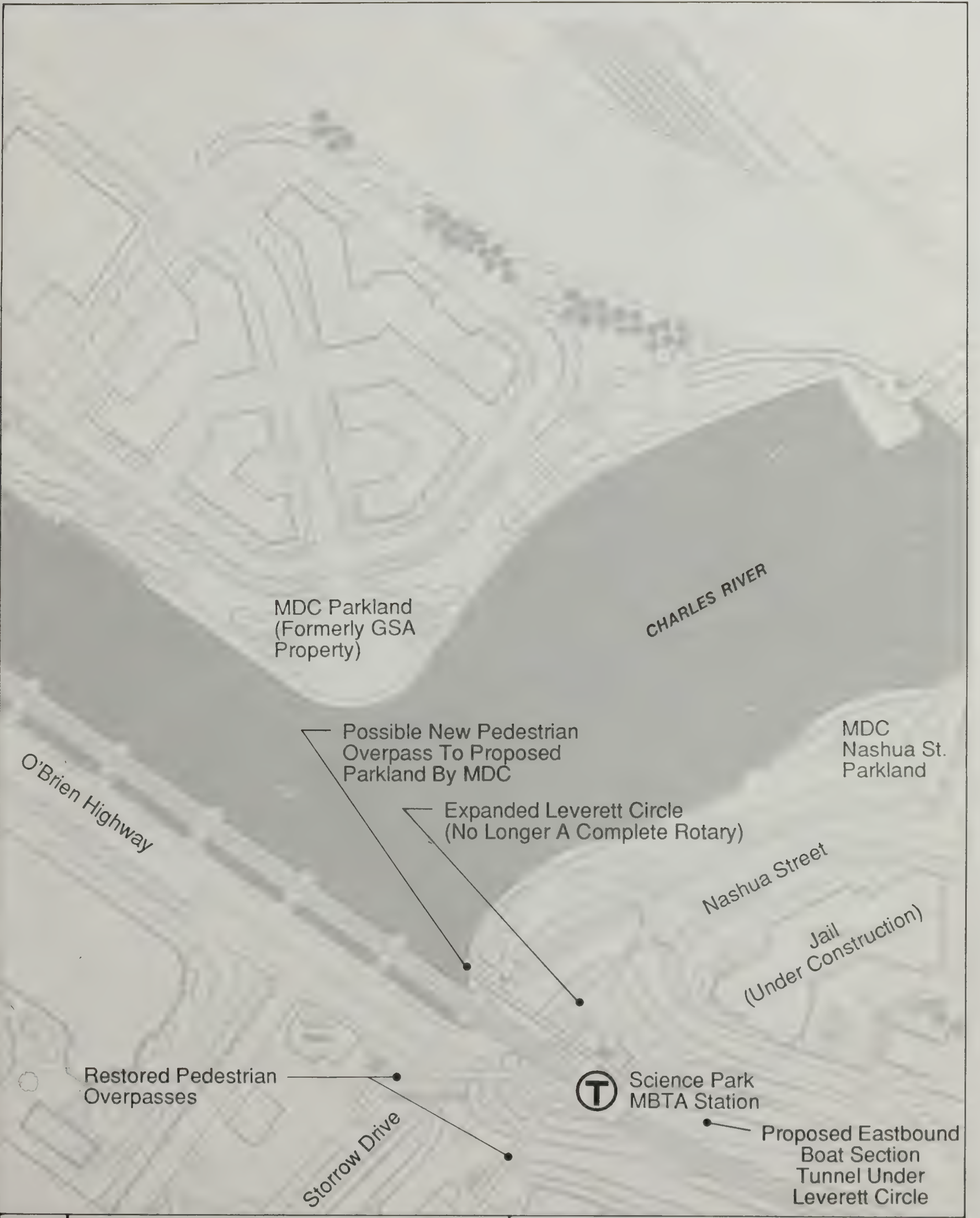

MDC Parkland (Formerly GSA Property)
CHARLES RIVER
MDC Nashua St. Parkland
Possible New Pedestrian Overpass To Proposed Parkland By MDC
O'Brien Highway
Expanded Leverett Circle (No Longer A Complete Rotary)
Nashua Street
Jail (Under Construction)
Restored Pedestrian Overpasses
Science Park MBTA Station
Proposed Eastbound Boat Section Tunnel Under Leverett Circle
Storrow Drive

FIGURE 17

Illustrative Improvements To Leverett Circle, Nashua St. Parcel And GSA Site

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

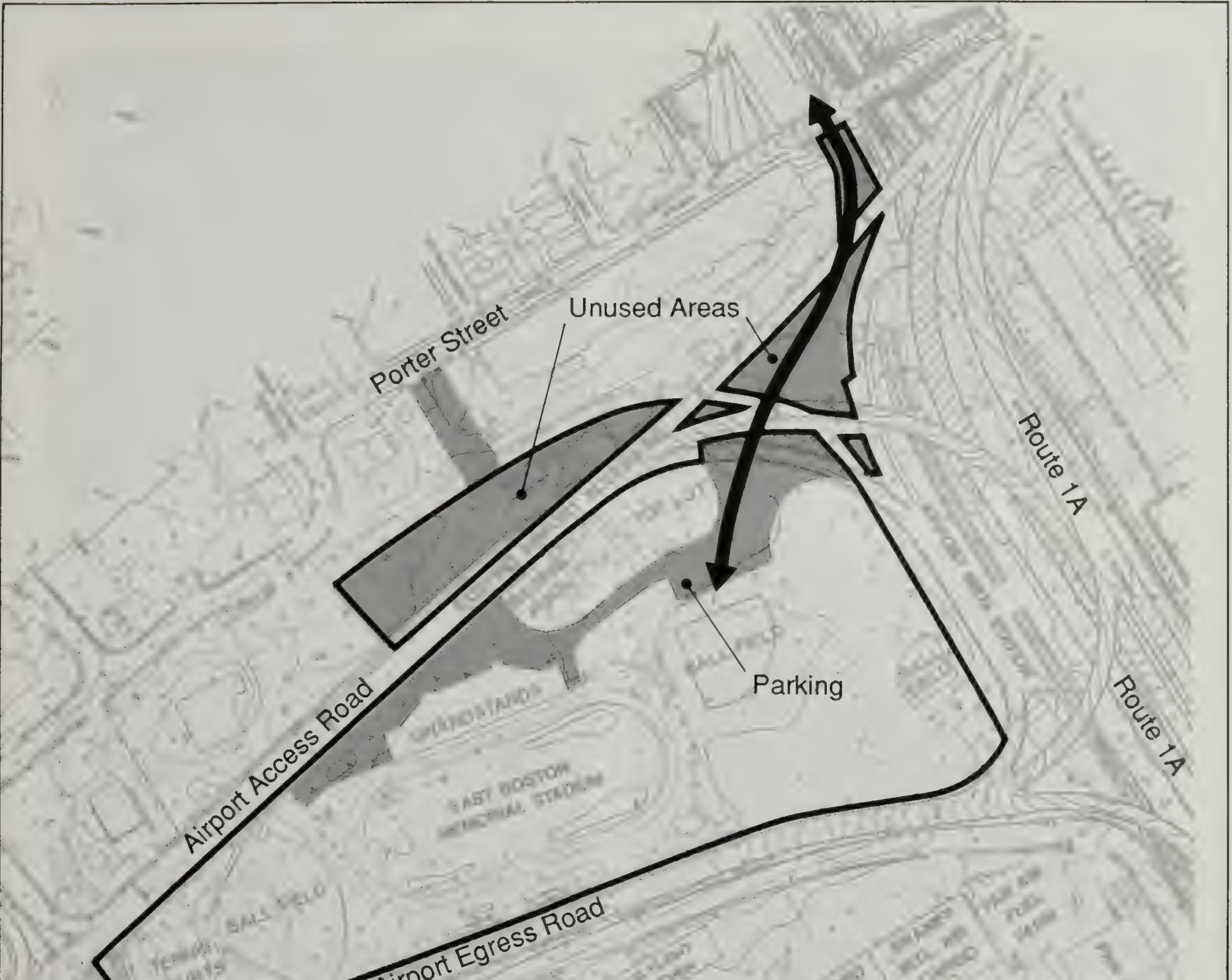


FIGURE 18

Existing Parkland East Boston Memorial Stadium Park

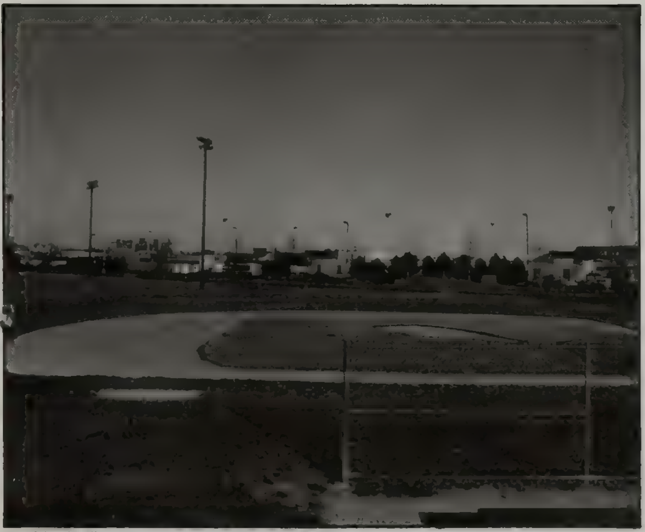
THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

Ballfield in northeast corner of park, looking northwest to MBTA bus station and bus ramp in background.

Tot lot play area and wading pool in southwest area of park, airport access road in background.

Baseball diamond facing the diamond shown in top left photo, looking southeast to grandstand.

Football/soccer field and grandstands, looking west.


Softball diamond east of football field, looking northwest.

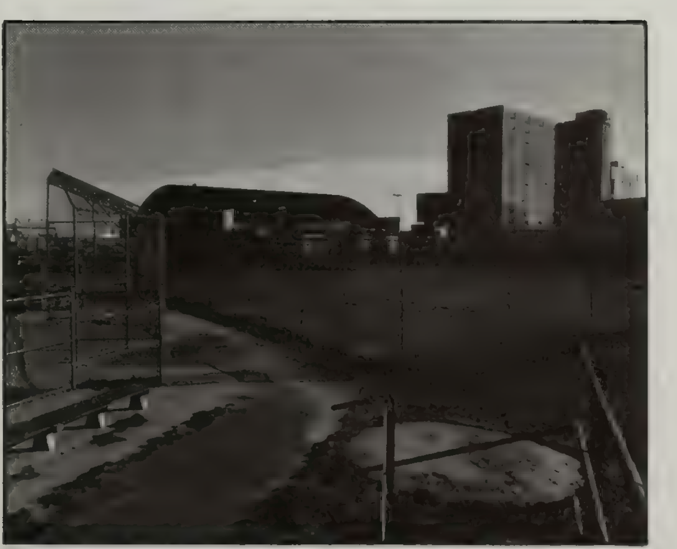

Tennis courts and softball backstop at east end of park, looking north.

FIGURE
19

Views of East Boston Memorial Stadium Park: Facilities For Active Recreation

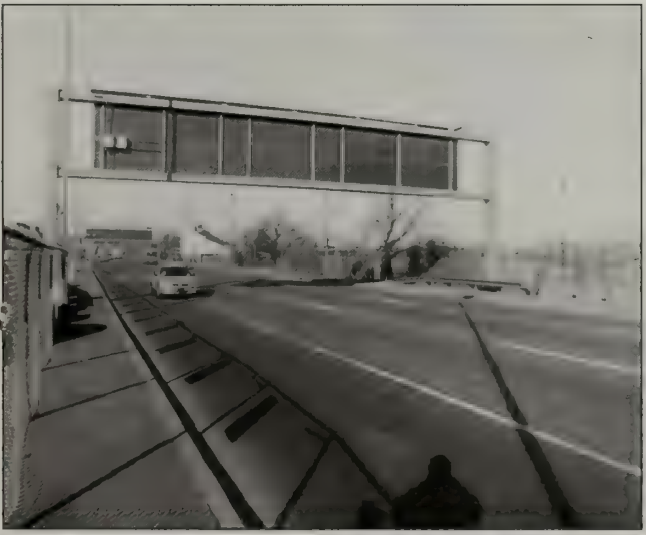
THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

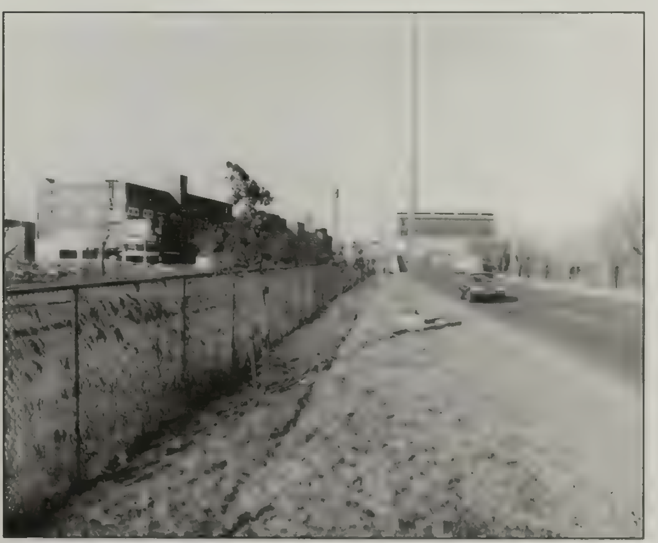
Main entrance to East Boston Memorial Stadium Park from Porter Street.

Overhead ramps near Porter Street entrance to park will be removed.

Area under overhead ramps will be landscaped when they are removed.

Existing undeveloped parkland adjacent to Airport Access Road.


Removal of Airport Access Road will allow expansion of park towards Porter Street (toward left side of photo).


Airport Access Road to be removed now separates park from expansion area to left.

FIGURE

20

Views Of East Boston Memorial Stadium Park

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

In addition, the stadium is considered a Citywide and regional resource. The football field is the home field for East Boston High School games and practice. It also is used by eight Boston Park League football teams and by 1,200 boys in the East Boston Youth Athletic Association football program. The football field is used for competition by two Statewide soccer associations which play four games or more per week in season. It is used as well for a Citywide summer recreation program for handicapped and emotionally disturbed children, which serves over 300 children daily.

The baseball and softball facilities are used as home fields for East Boston High School, by 16 baseball and 22 softball teams in the Boston Park League, and by the East Boston Girls' Softball League. Most of the airlines at Logan Airport have a team in the Massport League which holds softball games two nights per week. In addition, the East Boston Little League maintains a separate baseball diamond within the stadium complex.

In spite of limited play facilities, the tot-lot and wading pool area are heavily used. East Boston Social Center, Inc., uses the area as a part of its summer Day Care Center program, which serves hundreds of children each day.

Present access for both pedestrians and vehicles is at the southwestern corner of the park, via a paved area which passes under the existing inbound airport ramps and runs along the edge of the park. According to the 1954 deed to the parkland, the Boston Parks and Recreation Department easement under this roadway is for pedestrians and service vehicles only, but it is used for general automobile access. The 1954 deed also provides an easement for public vehicular access from Porter Street to the parcel southwest of the inbound airport road and a pedestrian easement between this parcel and the main field.

Although the facilities themselves do not possess any unusual characteristics, the fact that this park is a replacement for parkland previously taken for airport expansion makes any encroachment on it of major concern to the community.

2.2.3 Impacts On Section 4(f) Property

Permanent Use Of Land. No parkland at the East Boston Memorial Stadium Park will be used permanently by the Proposed Action. As a result of further study, the alignment of the Proposed Action has been shifted since the FEIS/R to avoid the park entirely (see Figure 21). In comparison, the Preferred Alternative in the FEIS/R would have used 34,000 square feet at the park's southeastern end for a permanent subsurface easement for a ramp.

Air Quality And Noise Impacts. Air, noise, and vibration impacts at the park under the Proposed Action are discussed in greater detail in Chapters 4 and 5 of Part I of this SEIS/R. Air quality would be slightly improved by the project. Modelled carbon monoxide concentrations at the park in 1987 were 7.4 ppm (1-hour) and 4.7 ppm (8-hour). Without the project predicted 1-hour and 8-hour concentrations in the year 2010 would be 5.0 ppm and 3.1 ppm. With the project, these concentrations would be reduced slightly to 4.7 ppm and 3.0 ppm, respectively.

Noise impacts would vary by location within the park. At the park's west baseball field, existing AM and PM noise levels are 62 and 63 dBA respectively. Without the project, year 2010 noise levels would be 63 and 65 dBA; with the project these levels would be approximately the same, 63 and 64 dBA. (A change of 3 dBA is the smallest that most people can perceive.)

At the park's east baseball field, AM and PM noise levels are currently 68 and 69 dBA. Without the project, year 2010 noise levels would be 71 and 72 dBA at the east ball field; with the project these levels would be approximately the same, 70 and 72 dBA. At the tennis courts at the east end of the park, existing AM and PM noise levels are 65 and 68 dBA respectively. Without the project, year 2010 noise levels would increase to 67 and 71 dBA; with the project these levels would be slightly higher, 72 and 74 dBA, or 6 to 7 dBA higher than existing levels.

Since these noise levels are perceptibly higher than existing levels and above FHWA noise abatement criteria for parks (67 dBA), noise abatement has been recommended, as discussed below in Section 2.2.5, Measures to Minimize Harm. With mitigation, noise from traffic would not impair recreational activities such as softball and tennis in areas close to the edge of the park. The Proposed Action also eliminates a major airport access road which is currently near the park's tot-lot.

Alternative toll plaza locations in East Boston (selected) and South Boston (rejected) were evaluated. (Neither toll plaza location would permanently use park property or affect the amount of parkland temporarily occupied.) The East Boston toll plaza would result in the same predicted carbon monoxide concentrations near the park as the South Boston toll plaza. Noise levels would be up to 3 dBA lower near the park with an East Boston toll plaza, because traffic would pass the park at lower speeds. In general the East Boston toll plaza location has environmental consequences equal to or better than those of the South Boston Alternative.

Construction Period Impacts. Construction of the Proposed Action (I-90) through Logan Airport and its connection with Route 1A temporarily will use some parkland, as described below. No long-term interest in the land will be retained, and additional land will be added to the property.

Construction activities will occur on all sides of the park at various times. Several aspects of work in the area of the MBTA Airport station have the potential to affect the use of the park.

Of least impact would be the use of approximately 4,500 square feet of parkland (a 15- by 300-foot strip) for approximately 9 months during construction of the boat section bus ramp near the station. No trees will be displaced, however, and existing trees will be protected in place to ensure their survival and vitality. This work would occur in the northwest corner of the park, approximately 80 feet from the nearest recreation facility, a softball field facing away from the work area. There will be no adverse affect on recreational activity due to this temporary occupancy, which will not interfere with this ball field.

In addition, during the latter part of construction of Stage II of the construction staging plan for this area, access to the park will remain open, but all park users must cross a proposed construction haul road (see Chapter 20 of Part I for a discussion of construction staging and the plan for the proposed haul road). Several construction vehicles per hour, servicing the proposed East Boston concrete batch plant, will travel via the haul road

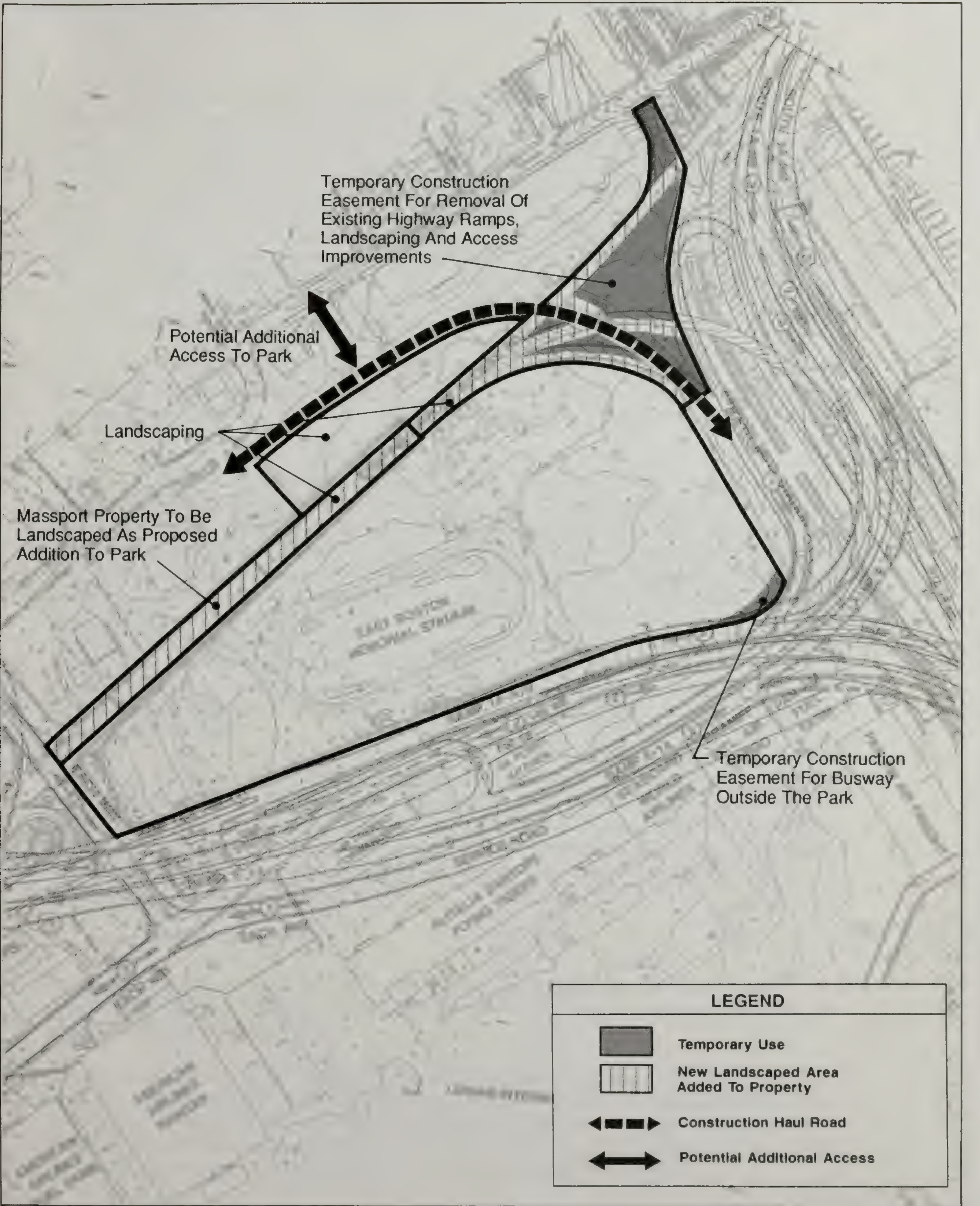

Temporary Construction Easement For Removal Of Existing Highway Ramps, Landscaping And Access Improvements
Potential Additional Access To Park
Landscaping
Massport Property To Be Landscaped As Proposed Addition To Park
EAST BOSTON MEMORIAL STADIUM
Temporary Construction Easement For Busway Outside The Park
LEGEND
Temporary Use
New Landscaped Area Added To Property
Construction Haul Road
Potential Additional Access

FIGURE 21 Proposed Uses In The Area Of East Boston Memorial Stadium Park

running outside and along the southwestern edge of the park on the site of an abandoned rail spur. This temporary haul road will avoid disrupting airport and local traffic on East Boston streets. To provide safe access to the park, a designated pedestrian crossing will be provided. At this point, construction vehicles will be required to stop for pedestrians going into and out of the park. Safe passage would be enforced with a painted crosswalk, speed limit sign, traffic lights, flagman, and crossing gate, and/or a crossing officer. Such controls will be required for a period currently estimated at 2 years, until the completion of the work. A pedestrian overpass or alternate access route were investigated but judged to have adverse impacts on access and safety, compared to a controlled grade crossing. Construction haul Road access will cross existing park access easement on paved areas and will not require the use of landscaped areas.

For a short period during construction Stage IV (for approximately 3 to 6 months), buses to the MBTA Airport station will be detoured under the existing bus loop and will need to use the haul road across the park access easement. Park access will be protected as discussed above.

Some alteration of park access will occur during demolition of the elevated structures supporting the existing airport access ramps. Removal of these roadways will open the area and reunite the now isolated parkland southwest of the access road, and this represents a substantial benefit to the park despite the temporary use. Approximately 2 acres of land in four areas near Orleans Street, between the elevated ramps and alongside a portion of the surface access road, will be required for approximately 4 months to accomplish demolition and removal of these facilities. The demolition and removal of the surface access road between the elevated portion and the service road to the east can take place in the roadway right-of-way, not entailing the use of any parkland, although construction activity may temporarily impair use of the adjacent tot-lot for part of the four-month demolition period. Demolition will be phased to provide continuous alternative access to the park from Porter Street.

In conclusion, no parkland will be permanently used, but there will be temporary occupancy of some areas. While the temporary occupancies for construction of the busway and demolition of the overhead ramps are not in themselves sufficient in duration or adverse effect to constitute a 4(f) use, the haul road and bus detours would adversely affect access to the park if not effectively mitigated in the manner described above. There may consequently be a temporary 4(f) use.

2.2.4 Avoidance Alternatives

As discussed in the FEIS/R Section 4(f) Evaluation, no prudent and feasible alternative can completely avoid the property because of its proximity to airport roadways. However, no parkland will be permanently used.

The Preferred Alternative as described in the FEIS/R, which was approved in 1985, would have required a subsurface easement of 34,000 square feet of parkland for a subsurface ramp. The FEIS/R Preferred Alternative also would have required two temporary construction easements, a 10-foot-wide strip along the southwestern edge of the park (6,000 square feet) for 2 years and a 40-foot-wide strip at the tennis courts (34,000 square feet) for 3 months.

The Proposed Action involves a redesign of the airport interchange, shifting all roadways to the north edge of the park and avoiding all permanent use of land or easements. However, the only construction access to a concentrated area of highway ramps north and west of the park is via a construction haul road between the park and the adjacent MBTA Blue Line station and tracks. This construction activity temporarily affects access to the park. Alternate construction access routes are not possible because of the Blue Line tracks, heavy volumes of traffic on the airport egress road, and the park itself. Similarly, short construction occupancy of small areas of the park for heavy construction and ramp demolition are unavoidable because of the park's proximity to the airport roadway roadway system.

2.2.5 Measures To Minimize Harm

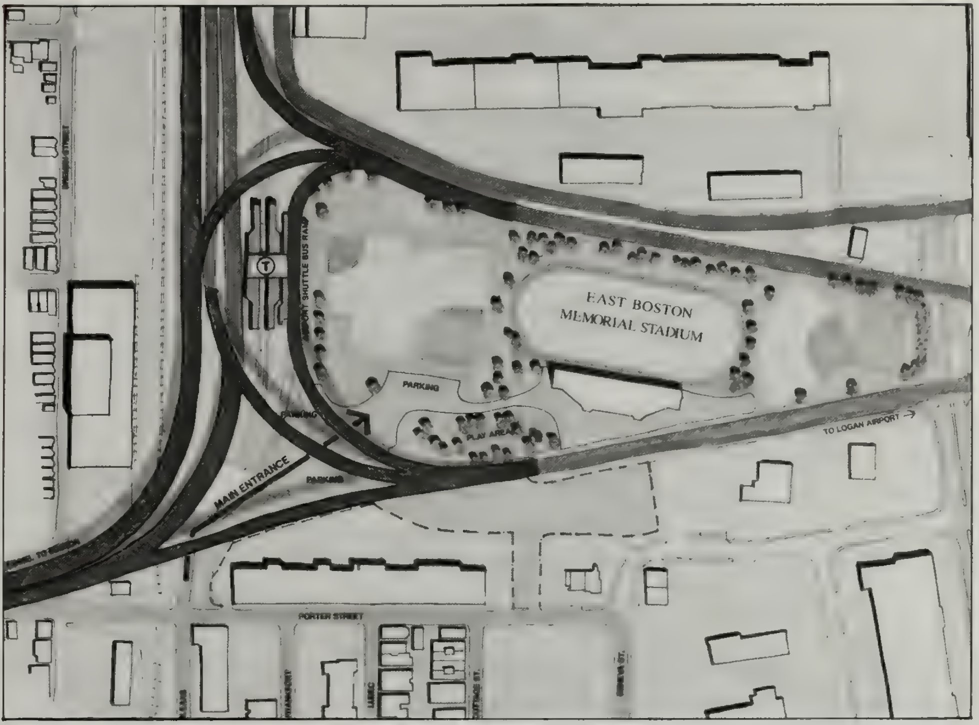
A major objective of the engineering and environmental reviews of the Preferred Alternative in the 1985 FEIS/R was to substantially reduce or avoid, if possible, use of any parkland at the East Boston Memorial Stadium Park. The Proposed Action was developed with input from the Boston Parks and Recreation Department and East Boston residents. It reduces temporary use and substantially improves community access to the property after the completion of the work in East Boston. It maximizes benefits to the park to the extent possible, while providing regional highway connections and airport access.

Although a 4-month construction easement is required for removal of the existing elevated access ramps and surface airport access road, which currently separates the park from the community it is intended to serve, upon completion this will be a major benefit of the Proposed Action. The abandonment and removal of these ramps and roadways will allow the potential unification of park segments now covered by ramps and/or separated by the roadway. In addition, accessibility to the park from both Orleans Street and Porter Street will be substantially improved, and a much better environmental quality for intended park uses will be achieved by removing the airport access ramps.

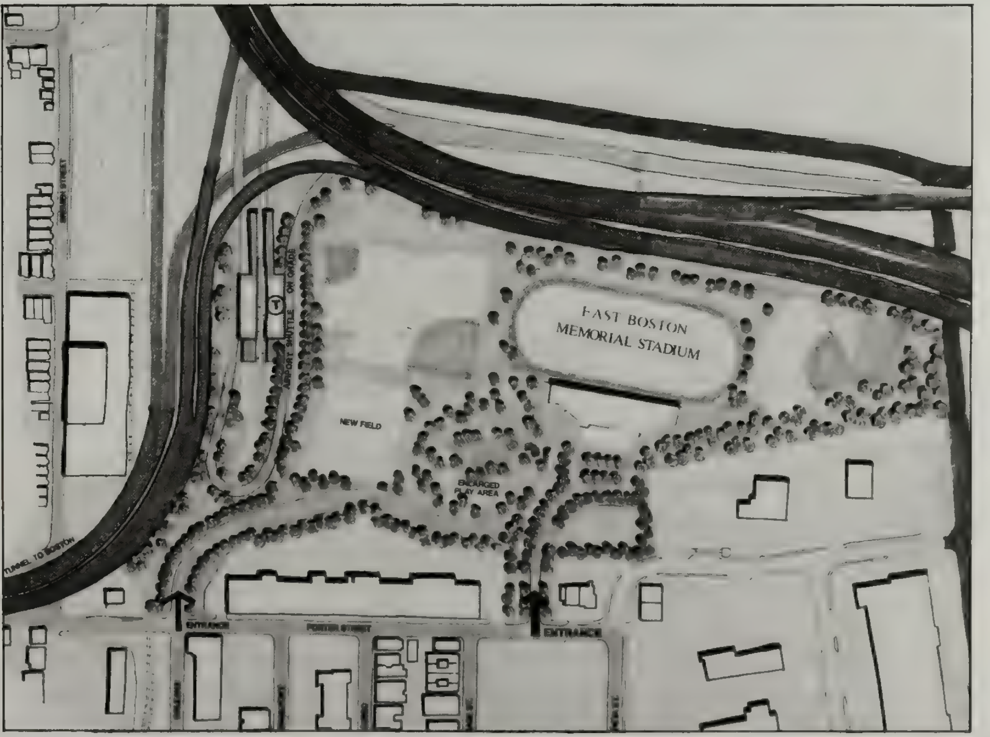
During removal of the three overhead ramps near the Porter Street entrance to the park, safe and protected access via Porter Street near Cottage Street will be maintained during the removal of the airport access ramps, which is in itself a major benefit to the park. After removal, this section will be landscaped appropriately to enhance its role as the park's main entrance (see Figures 21 and 22). Measures such as root pruning will be used to ensure the survival and vitality of trees near the excavation for a depressed bus ramp adjacent to the northwest corner of the park.

After demolition and removal of the overhead ramps and the surface road are completed, the area will be restored and developed as parkland. Parkland disturbed in the northwest corner due to construction of the airport busway in boat section will be landscaped and restored. In addition, the undeveloped parkland adjacent to and south of the access road will be developed, providing another access point to Porter Street between Cottage and Geneva Streets. Park planning details will be determined during the design phase in cooperation with the East Boston community, the Boston Parks and Recreation Department, Massport, the MBTA, and other interested parties.

Based on the noise analysis summarized above and in Chapter 5 of Part I of this SEIS/R, a 16-foot-high noise barrier is recommended between the Proposed Action and the park to provide approximately a 11-dBA noise reduction.



Existing conditions



Proposed landscape plans

FIGURE 22

East Boston Memorial Stadium Proposed Landscaping

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

2.3 SPECTACLE ISLAND

2.3.1 Proposed Action

Alternative materials disposal options for the Proposed Action are described in detail in Chapter 4 of Part II of this SEIS/R. The preferred disposal option involves the development of a confined marine disposal site at Spectacle Island in Boston Harbor for dredged and excavated material generated by the project. This would take the form of a phased disposal program followed by landscape improvements, leaving the island suitable for expanded active and passive Harbor islands park use.

2.3.2 Description Of The Section 4(f) Property

Spectacle Island is located approximately 6,000 feet from the mouth of Boston's Inner Harbor. Its area is 83 acres at mean high water and 97 acres at mean low water. It is owned by the City of Boston (approximately 77 acres) and the Massachusetts Department of Environmental Management (DEM) (approximately 20 acres). Spectacle Island is an undeveloped component of the Boston Harbor Islands State Park created in Chapter 742 of the Massachusetts Acts of 1970 (see Figure 23).

Landfill History And Conditions. Spectacle Island originally consisted of two rounded hills (drumlins) connected by a lower ridge (tombolo), but this original topography has been altered severely. The City of Boston used the tombolo area as a refuse dumping ground between 1912 and 1959, creating a landfill that has never been capped or stabilized. Although landfilling operations ceased around 1960, abandoned barges remain.

Approximately 38 of the island's 97 acres consist of refuse fill, which reaches estimated maximum depths of about 70 to 100 feet. In the area between the two natural drumlins, along the eastern and western shores, leachate is being released from the landfill into the Harbor, and, along the eastern edge, a white precipitate has been observed. Aerial photographs indicate that there has been considerable erosion of the refuse along that portion of the island over the past 20 to 30 years. (See Figure 24 for the island's existing resources and topography.)

Natural Resources. The northern side of the island has a rocky beach, with virtually no fine-grained material. The beaches on the western side are comprised of fine to medium sand, shell fragments, and smaller stone, indicating a lower wave energy environment. The beach on the southern portion of the island consists of medium-grained sand indicating a depositional environment of slightly more energy than the western beaches. The beach on the eastern side of the island is comprised of shell fragments, blue mussel beds, cobble, and fine sand.

There are two small wetland areas on the island consisting of a low saltmarsh in the northeast and a high saltmarsh in the south (see Figure 24). No shellfish beds occur within the limits of these saltmarshes. Approximately 15 acres of blue mussel (Mytilus edulis) beds, however, are located along the northern and eastern shores of the island, with those on the eastern shore receiving leachate from the eroding landfill.

Since landfilling ended in 1960, most of the island has revegetated with successional plant species. Spectacle Island has been a reported breeding ground for several bird species, including the Glossy Ibis, Black-crowned Night Heron, Green Heron, Snowy Egret, and the Great (Common, American) Egret. (See Chapter 4 of SEIS/R, Part II, for a more detailed description of vegetation and wildlife.)

Historic Resources. Spectacle Island also is listed in the National Register of Historic Places as a part of the Boston Harbor Islands Archaeological District for its known and potential prehistoric archaeological resources. One prehistoric site (19-SU-38) has been confirmed in a survey performed by the Office of Public Archaeology at Boston University in 1987. Documentary research has also indicated that numerous historical activities have occurred on the island since the 17th century. There are no existing significant historic resources on Spectacle Island. A Phase III archaeological data recovery operation is recommended. This site meets Criterion D for listing on the National Register but does not warrant preservation in place. As such, it is not subject to Section 4(f).

Park Planning And Current Use. Use of Spectacle Island is currently prohibited by DEM because of its hazardous condition. In its current state, Spectacle Island is not a functioning part of the Boston Harbor Islands State Park and its eroding banks and uncapped landfill actually degrade the harbor environment which is important to the park as a whole. Although the island would have great potential as a recreational resource if it is properly capped and stabilized, it has no value for park use in its current state, and planning by the City and DEM for its future use is contingent upon these improvements being made by others.

Spectacle Island was proposed for improvement and active use as a public park in both the original Boston Harbor Islands Comprehensive Plan (Metropolitan Area Planning Council, 1972) and the Boston Harbor Islands State Park 1986 Master Plan (Massachusetts DEM). The more recent plan designates it as potentially one of the five high use islands in the park (the others are Thompson, Long, Georges, and Peddocks).

The 1986 Master Plan specifically addressed the relationship between park development of Spectacle and the Central Artery project:

> "Whether or not it is developed for park use, Spectacle requires extensive stabilization to mitigate the environmental impacts of the eroding landfill...The stabilization project will be most feasible if spoil materials from a major public project such as the Central Artery/Third Harbor Tunnel are utilized."

The plan's cost estimates for development ($3 million for stabilization and $10 million for development) assumed that the necessary fill material would be provided and delivered to the island without cost.

Future ownership and control of the island as a public park by the City of Boston and/or the DEM is under active discussion and nearing resolution. The island has been considered by the Massachusetts Water Resources Authority from time to time for several years as a site for excavated materials disposal and sewage sludge processing facilities. As of the publication of this document, it appears that such uses would be inconsistent with both projects, and that they will be accommodated elsewhere.

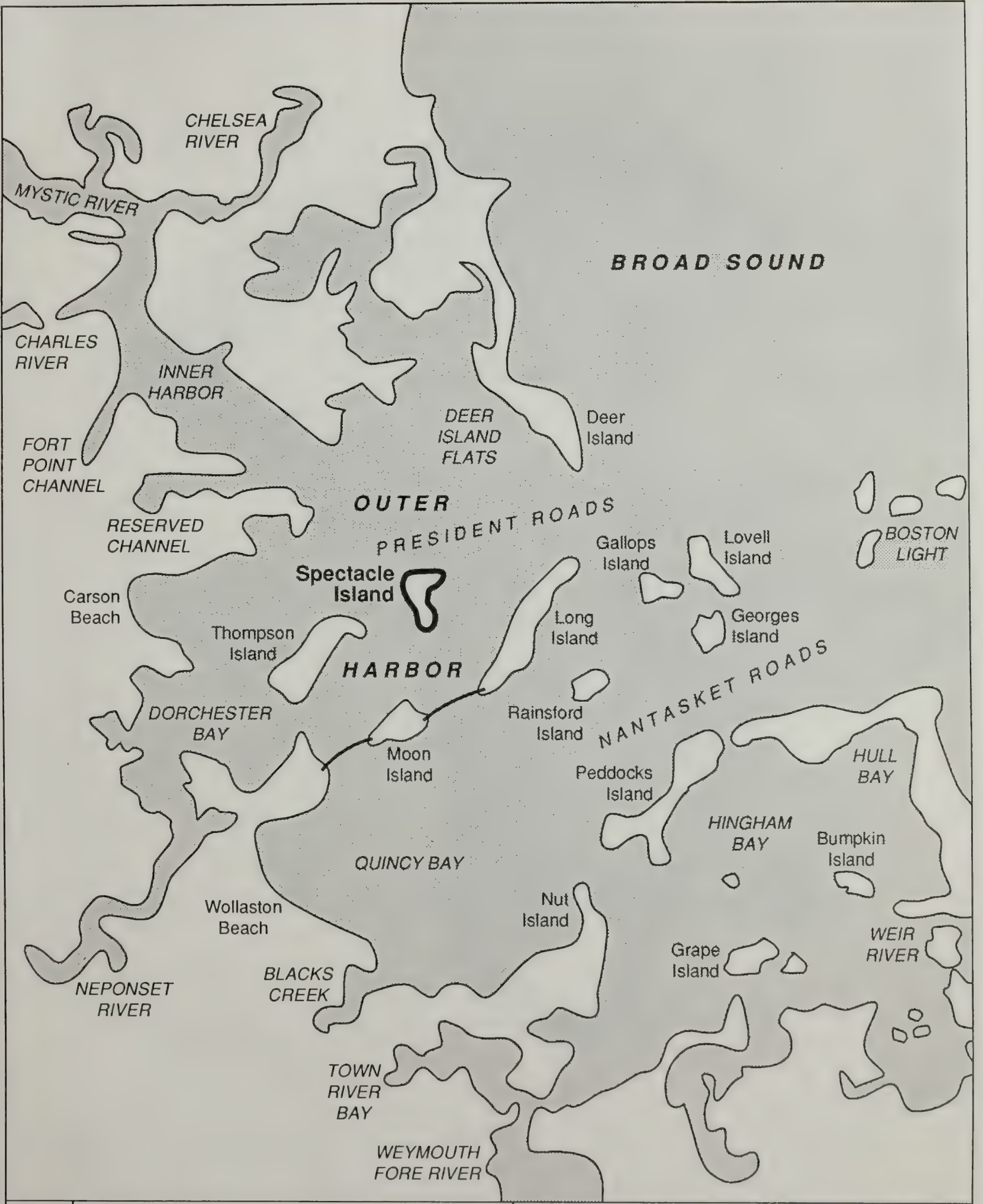
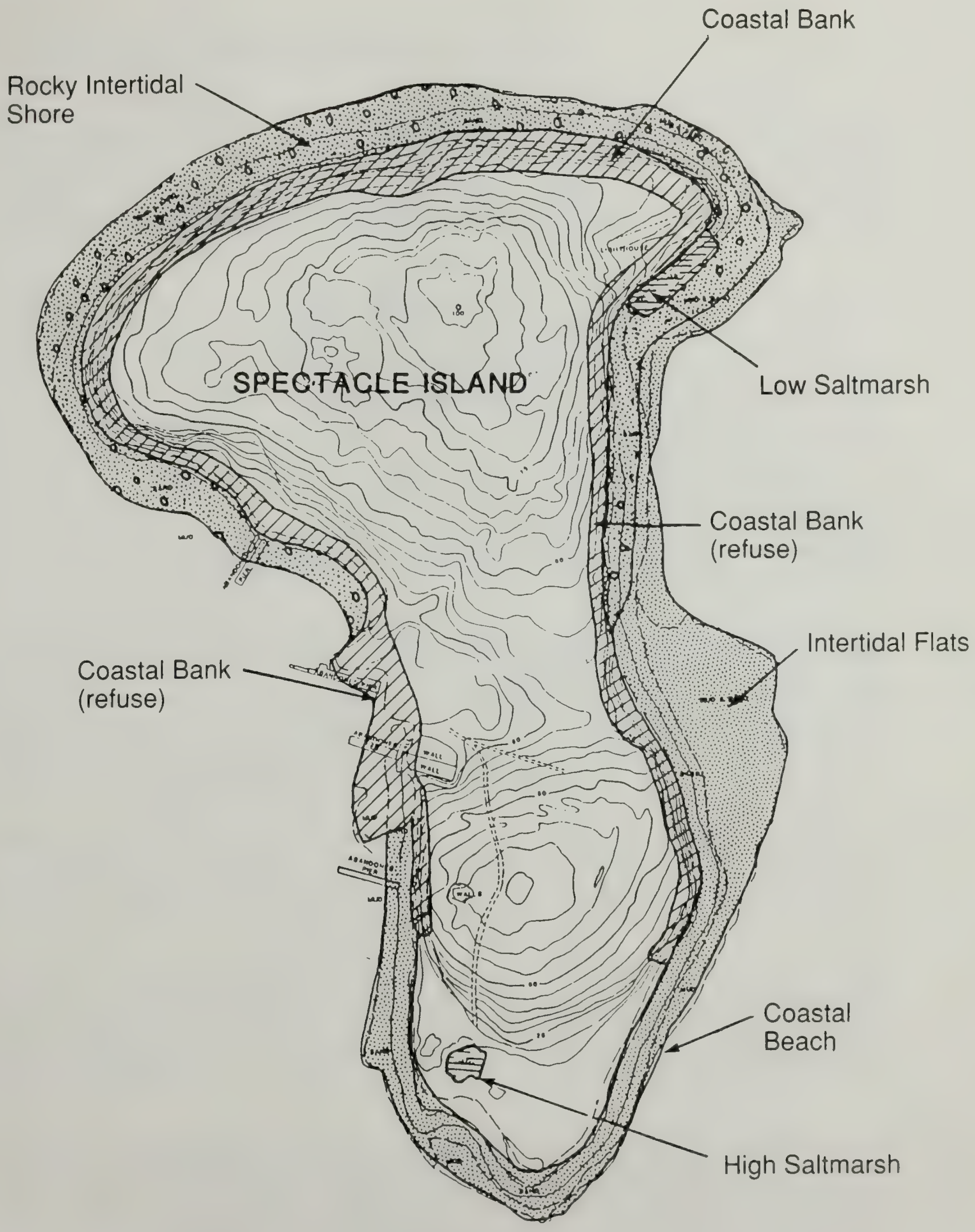


FIGURE 23 **Location Of Spectacle Island**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 0.5 1 Mile



FIGURE

24 **Spectacle Island Resource Areas**

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 250 500 1000 Feet

2.3.3 Impacts On The Section 4(f) Property

Spectacle Island is one of the final disposal sites described in detail in Chapter 4 of Part II of this SEIS/R. The preferred disposal option would involve the placement of excavated and dredged material on Spectacle Island. This activity provides capping of the existing landfill and stabilization of the island in a manner that is necessary to implement the Harbor Islands State Park Master Plan and which was foreseen in the plan, as discussed above.

Although Spectacle Island is a potentially valuable park resource which has been designated for park use, it is an unusual application of Section 4(f), since the Artery/Tunnel Project is supportive to any realization of its park potential. The magnitude of cost involved in stabilizing and capping the island, and the absence of any other foreseeable project which could provide these improvements for the park agency, also make the use of the island by the Artery/Tunnel Project necessary for it to become a significant park resource. Transformation of Spectacle Island through the Artery/Tunnel Project would take place as follows, if the preferred disposal option is approved. Detailed descriptions of impacts of the Proposed Action's impacts on Spectacle Island are presented in Chapter 4 of the SEIS/R, Part II, and also in the Materials Disposal System Conceptual Design Report, dated June 1989.

The Proposed Action anticipates disposal of approximately 9 million cubic yards of excavated and dredged material within a containment facility at Spectacle Island. This would result in an increase in the island's size (at mean high water) from 83 acres to 191 acres. The existing topography also would be changed due to disposal of material over most of the island, and the new fill would rise to a height not exceeding an elevation of 140 feet above mean sea level. (The proposed configuration is shown in Figure 25.)

The preferred disposal option includes construction of a containment facility in the waters around most of the island. This facility would be a rock dike which would rise to a maximum height of about 14 feet above mean sea level. The top of the dike would contain a construction haul road that would encircle the island.

The materials to be disposed would be placed in the area inside the dike and on Spectacle Island itself. Existing structures on the island would be demolished, and approximately 80% of the island would be covered with fill. (Existing topography and vegetation at the southern tip would be maintained or restored.) Mitigation measures would be implemented as described in Section 2.3.5.

The island then would be regraded and revegetated in a manner consistent with active and passive park uses and conservation. (Some portions of the island would be restored as wildlife habitats such as wetland which would benefit from greater separation from active use facilities.) This reconfiguration of the island would be beneficial since under all disposal options involving Spectacle, the island would be made available for park use. A positive benefit would therefore result.

2.3.4 Avoidance Alternatives

Spectacle Island is an unusual application of Section 4(f) because the island would become a park resource made possible by securing the deteriorating island for materials disposal purposes. Although the island is presently designated for park use in DEM's 1986 Master Plan, which specifically cites the Artery/Tunnel Project as a means to facilitate this use, it cannot be used as a park unless materials disposal is permitted. Thus, avoidance of the property would not be a benefit to the Boston Harbor Islands State Park of which Spectacle is part, but rather a missed opportunity to mitigate pre-existing environmental problems adversely affecting both Spectacle Island and the Park as a whole. Since the island is not presently usable as a park resource and because there is no other foreseeable opportunity to convert it into a park resource, there is no alternative to the use of the property by the Artery/Tunnel Project which would in fact allow the establishment of the island as a usable park.

2.3.5 Measures To Minimize Harm

The Spectacle Island disposal options would make it possible for longstanding parkland objectives for the Boston Harbor Islands Park system to be realized through capping, containment of existing contaminated conditions and the stabilization of Spectacle Island. To the extent that the preferred disposal option increases the size of the island, compared to combination inland/island disposal options, it would expand the limits of the park and increase recreational opportunities and other park-related benefits. The dike structures would be designed in a manner consistent with subsequent park use. After filling is complete, the island would be covered with topsoil, graded appropriately, and planted with grasses, shrubs, and trees in accordance with a park planting plan (see Figure 25). A gravel beach would be installed at the western shoreline, and a path around the island on top of the dike would be finished with crushed stone. The preliminary and final design for finish grading and planting are the subject of ongoing discussions with DEM, the City of Boston, and other parties with interests in park protection and development.

2.4 OTHER NEARBY PARKLANDS NOT USED OR AFFECTED

Nine additional existing parklands are either adjacent to or near the right-of-way of the Artery/Tunnel Project. The Proposed Action will not use any of these parklands nor impair intended activities. The following descriptions of these parklands and how the Proposed Action will relate to them are provided in support of this conclusion. The numbers in the following text are keyed to the location map in Figure 26.

2.4.1 Lester J. Rotch Playground, South End

The Rotch Playground (#1) is located on the eastern edge of the South End amidst industrial/commercial uses. The approximately 5.4-acre playground is moderately used by neighborhood youth who reach the park from Harrison Avenue. The playground, which consists of a ball field and a shelter, recently was reconstructed by the City of Boston Parks and Recreation Department, its owner.

No part of the playground will be permanently or temporarily occupied by the Proposed Action. While traffic increases are expected on Albany Street and the Southeast Expressway because of the Proposed Action, air, noise, and vibration impacts would not impair use of the park.

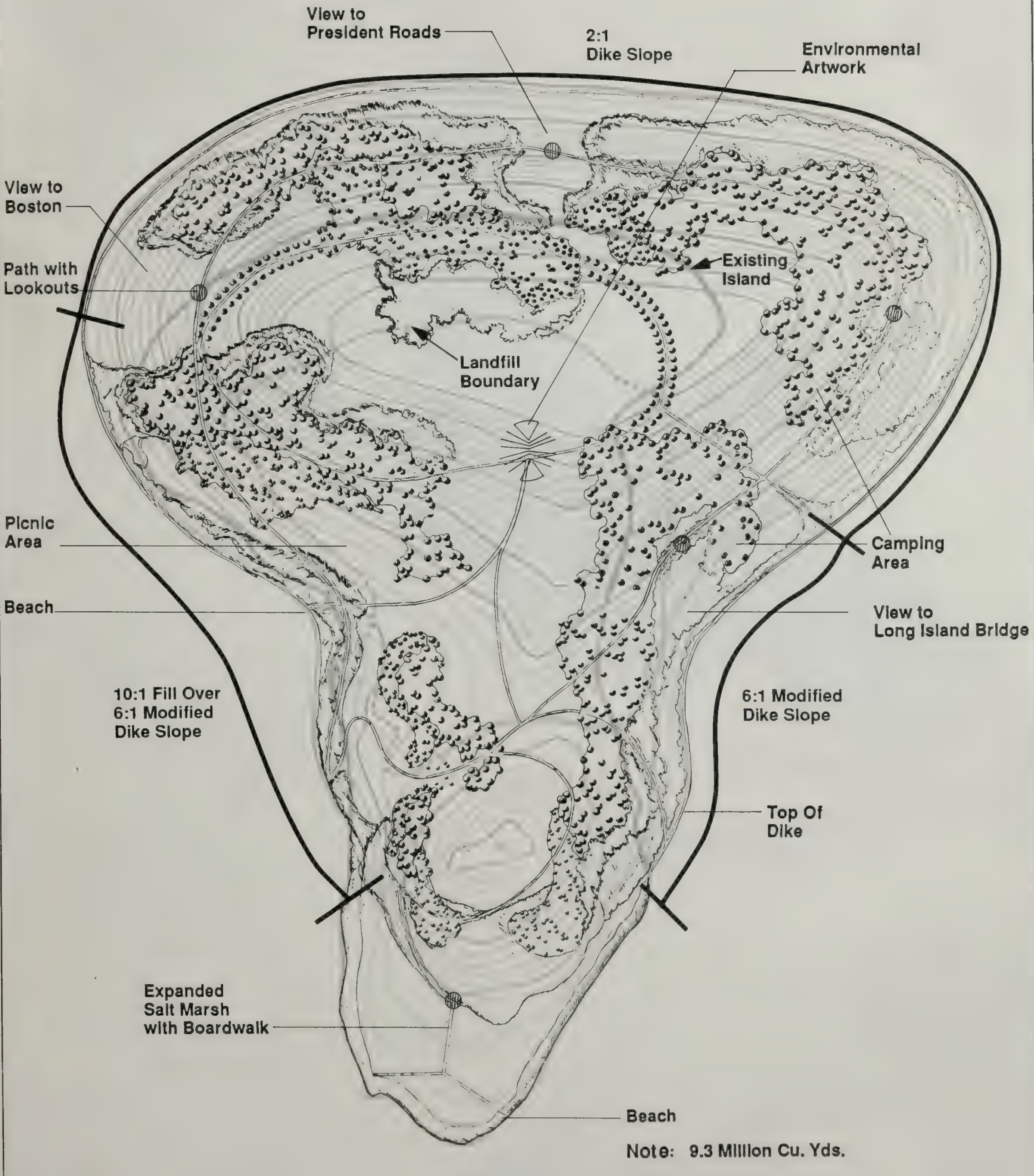


FIGURE 25 Proposed Spectacle Island Concept

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

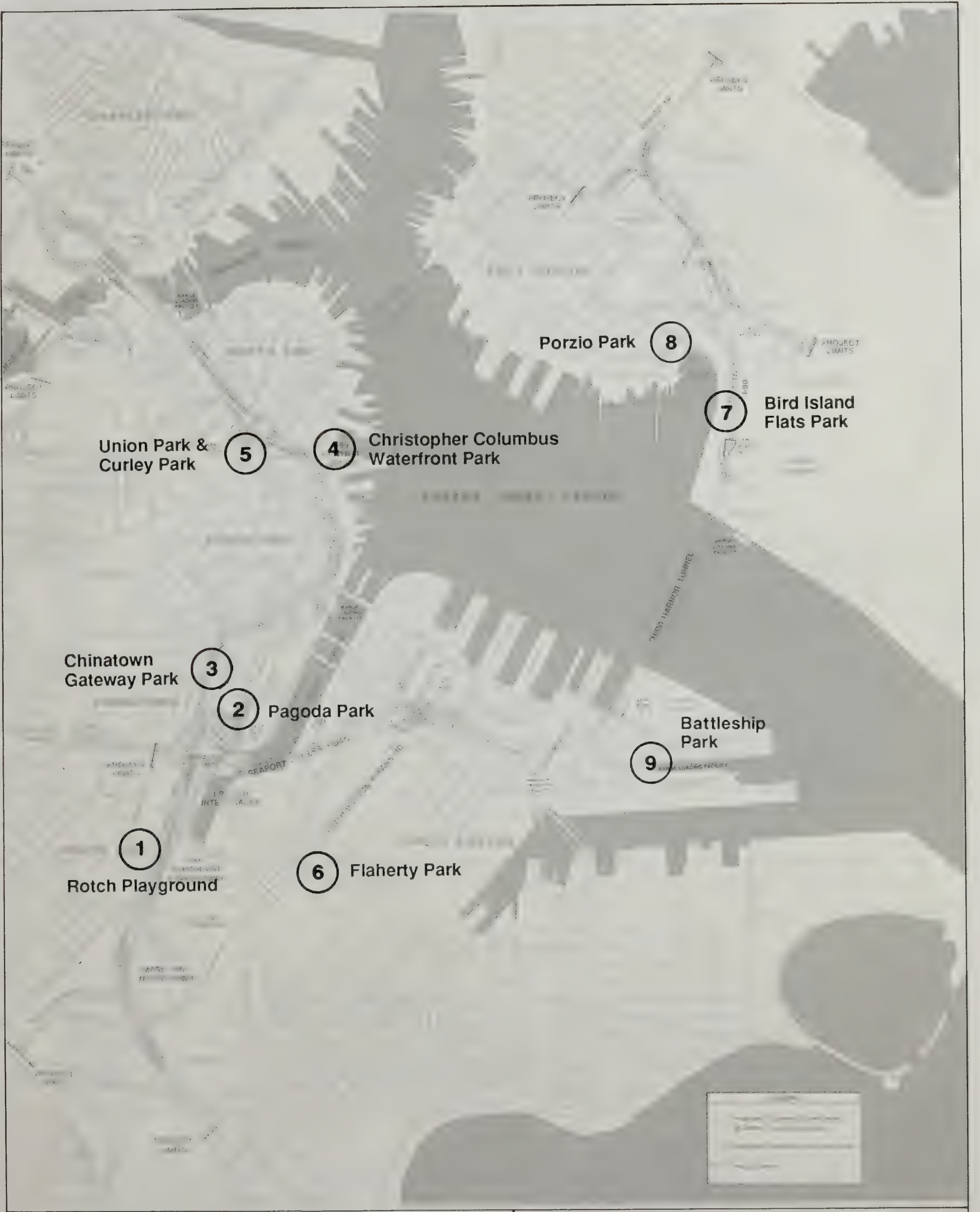


FIGURE 26

Parkland Unaffected By Proposed Action

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 800 1600 2400 3200 Feet

2.4.2 Pagoda Park, Chinatown/Leather District

Pagoda Park (#2) is located southeast of the intersection of the Southeast Expressway (I-93) northbound off-ramps to downtown Boston and Kneeland Street, opposite Lincoln Street, and just west of the Boston Thermal Corporation steam plant. This property is owned by the Massachusetts Turnpike Authority and temporarily used and maintained by the City of Boston Parks and Recreation Department by agreement. It was determined in the 1985 FEIS/R not to be subject to Section 4(f) and is addressed here for the purpose of completeness.

The park is bordered by highway uses on the west and south, office buildings in the Leather District on the north, and the steam plant on the east. The 1.47-acre playground is heavily used by Chinatown youth and nearby office workers during lunch hours who can enter the park only from Kneeland Street. It contains two outdoor basketball courts, a volleyball court, and a grassy area to the south. Scheme 5A Modified would have encroached on this park.

The Proposed Action will allow the potential expansion of the park southwesterly by approximately 0.6 acre because of the relocation of existing ramps as part of the Artery/Tunnel Project.

None of the highway construction will permanently or temporarily occupy any part of the existing park area, and access from Kneeland Street will be unaffected at any time. Air, noise, or vibration impacts are expected to be equal to or better than present conditions since mainline traffic movements on I-93 will be cut in half because of the realignment of the northbound mainline further away from Pagoda Park. Therefore, no impairment of use will occur.

2.4.3 Gateway Park, Chinatown

Chinatown Gateway Park (#3) is a small 0.13-acre plaza located directly adjacent to and southeast of the intersection of the Surface Artery and Beach Street. A decorative archway over Beach Street marks the east entrance to Chinatown next to the park. It was developed by the BRA in 1984 and is owned by the Boston Parks and Recreation Department.

The Proposed Action will not permanently or temporarily occupy any part of the park, and it will result in changes to the local street pattern nearby that will have entirely positive effects on the park.

2.4.4 Christopher Columbus Park, Downtown Waterfront

Christopher Columbus Park (#4), approximately 4.3 acres in size, was developed in the mid-1970s by the BRA which owns and maintains it. The park is the terminus of the Walk-to-the-Sea pedestrian way between City Hall and Boston Harbor. The park contains fountains, benches, the Rose Kennedy Rose Garden, a playlot, and landscaped areas. The park is heavily used by residents, nearby workers, and tourists on warm sunny days, on New Year's Eve to watch the fireworks over Boston Harbor, or for various special events.

The Proposed Action will not permanently or temporarily occupy any of the park area. Long-term benefits will be substantial due to the removal of the existing elevated Artery which separates the park from downtown Boston and is an unsightly visual barrier.

2.4.5 Union Park And Curley Memorial Park, Haymarket Area

Union Park and Curley Memorial Park (#5) are adjacent to each other and share a landscaped median strip between New Congress Street and Union Street. The approximately 0.48-acre rectangular park was built in the 1970s by the BRA. It contains landscaping, two unique bronze sculptures of former Mayor James Curley, and benches. The statues attract many visitors, and the benches are very popular with persons viewing the busy historic Haymarket area activities. The City of Boston owns and maintains Union Park (northern half of the rectangle), and the BRA owns and maintains Curley Park (southern half of the rectangle).

Union Park will be 60 feet from the closest corner of the proposed replacement parking garage/tunnel ventilation building which will be built as a part of the Proposed Action on BRA designated Parcel 7 across Hanover Street from the park. Construction on Parcel 7 will not impair the existing use of Union and Curley Parks nor impede access to them. No adverse long-term effects will occur as automobile access to the garage will be only from New Sudbury Street, and the ventilation structure will be on the Blackstone Street side of the building. Construction and access to construction on Parcel 7 will be carefully controlled to assure that there is no short-term negative effect on Union Park. Therefore, no impairment of use will occur.

2.4.6 John S. Flaherty Park, South Boston

The John S. Flaherty, Sr. Memorial Park (#6), administered by the City of Boston Parks and Recreation Department, is located adjacent to and 22 feet above the Conrail railroad cut, and west of B Street between West Third Street and Bolton Street. As described in greater detail in the SEIS/R for the South Boston Haul Road, the 0.23-acre playlot includes play equipment for small children, benches, landscaping, and lighting. The playlot is heavily used by children and adults of all ages, who must cross busy A and West Fourth Streets to reach it.

The Proposed Action includes the southerly extension of the South Boston Haul Road (the latter to be built in advance of the Proposed Action as a construction mitigation measure). This extension will create the South Boston Bypass Road, which will be used only by trucks and high-occupancy vehicles between the Southeast Expressway (I-93) and the Seaport Access Road (I-90). No portion of the park will be permanently or temporarily occupied.

Air pollution impacts from trucks using the Bypass Road are expected to be negligible. This is because of the differences in elevation and distance from the playlot, and the consequent reduction in truck traffic on local surface streets because the same vehicles will be attracted to the Bypass Road. This shift in traffic to the Bypass Road will improve access to the park.

The Project would increase PM noise levels to 71 dBA, compared to the existing 57 dBA and the year 2010 baseline level of 65 dBA. However, the park is small and located in an urban setting in which traffic on immediately surrounding streets is part of its existing ambience, whereas traffic resulting from the project would be located in a former railroad cut 22 feet below the park. The park's active playground uses would not be substantially impaired by the resulting noise levels. Appropriate abatement measures have been considered, such as a dual function noise and visual barrier constructed along the western edge of the park, with landscaping treatments in any remaining area between the barrier and the park.

2.4.7 Bird Island Flats Park, East Boston/Logan Airport

The Section 4(f) Evaluation in the FEIS/R indicated that a proposed park was to be built along the western edge of Bird Island Flats overlooking Jeffries Cove in East Boston, and that it would not be affected by the Preferred Alternative. Since then, a narrow strip park referred to as the Bird Island Flats Park in this document has been built by Massport near the Massachusetts Technology Center (a private office building). The park was built pursuant to an agreement with East Boston residents. It contains a landscaped walkway and shelter providing spectacular views of Boston Harbor and the downtown skyline for Massachusetts Technology Center workers and East Boston residents who jog or walk along the path. The park is owned and maintained by Massport.

The Third Harbor Tunnel (I-90) connection to Route 1A, including the reconstructed Harborside Drive, will be approximately 190 to 500 feet east and north of the park. Accordingly, the Proposed Action will not permanently or temporarily use the park property and will not impair intended recreational activities there as it is separated from the park along most of its length by the Massachusetts Technology Center. This reaffirms the conclusion already reached in the FEIS/R that the project will not impair use of the park.

2.4.8 Porzio Park, East Boston

Porzio Park is located in the Jeffries Point neighborhood of East Boston near Sumner and Marginal Streets (#8). The 2.38-acre park faces Boston Harbor and is used for both active and passive recreation. The park, administered by the City of Boston Parks and Recreation Department, is primarily paved with minimal landscaping. It contains two tennis courts, 2.5 courts for basketball, a street hockey court, and a large sitting area.

The Proposed Action will be located approximately 1,000 feet north of Porzio Park. Construction and permanent impacts will be negligible.

2.4.9 Battleship Park, South Boston

Battleship Park is located on Tide Street near the head (west end) of Dry Dock #3 in the Boston Marine Industrial Park in South Boston (#9). The approximately 0.5-acre park is owned by the City of Boston's Economic Development and Industrial Corporation and was developed by EDIC in the fall of 1989. The purpose of the park is to provide a platform for viewing maritime operations in the dry dock such as the scheduled refurbishing of the U.S.S. Massachusetts. The park contains a raised platform for viewing, a ramp leading to it, six park benches, and six trees, paving, and other landscaping. To date, the park is used daily by a few industrial park tenants during good weather, particularly at lunchtime. Thousands are expected to view the U.S.S. Massachusetts activities. Vehicular and pedestrian access is from Tide Street. Parking is available off nearby Dry Dock Avenue.

The Artery/Tunnel Project will not permanently or temporarily occupy any part of the park and will not impair use of the park, which is located in a busy industrial area. During the construction period trucks hauling excavated materials to the proposed marine disposal barge loading facility along the north side of Dry Dock #3 will use Tide Street. Alternatively, the trucks could pass between the park and the head of the dry dock via an existing driveway.

Trucking operations will be temporary, occurring only during the early excavation phase of the construction period. Peak use of this barge loading facility will be during 1993 and the first half of 1994 when up to six barge loads of material will be removed daily. An average of 650 truckloads per day during the peak periods in 1993 and 1994 will be generated by excavation in the South Boston/I-93/I-90 Interchange area. The Dry Dock #3 barge loading facility is scheduled for use between 1991 and 1998. Viewing marine activities in the dry dock will not be impaired by these activities.

3 HISTORIC RESOURCES

This section of the Section 4(f) Evaluation is an update of the FEIS/R Section 4(f) Evaluation. The evaluation of Project impacts on historic resources has been reviewed and concurred with by the SHPO.

The Section 4(f) Evaluation in the 1985 FEIS/R for the Artery/Tunnel Project indicated potential impacts of the Preferred Alternative (5A Modified) on historic resources in three historic districts: Charles River Basin Historic District; Causeway/North Washington Streets Historic District; and Fort Point Channel Historic District (see Figure 27). FEIS/R determinations of adverse effect on historic properties conformed to the Preliminary Case Report prepared pursuant to Section 106 of the National Historic Preservation Act, and mitigating measures were consistent with the resulting 1984 Section 106 Memorandum of Agreement (MOA) among consulting agencies.

Since the FEIS/R, impacts on historic properties have been reduced. The Department has been involved in the process of complying with the MOA, and project design refinements have reduced 4(f) impacts. In summary, the Proposed Action has significantly fewer impacts to the Fort Point Channel District in comparison to the Preferred Alternative in the FEIS/R. The proposed design refinements to the Preferred Alternative will eliminate use of historic resources in the Causeway/North Washington Streets District and the Charles River Basin Historic District, and these resources are addressed here primarily as an update of the 1985 Section 4(f) Evaluation.

Many other historic properties and districts are located within sight of the existing elevated Central Artery in Boston. For these resources, the Artery/Tunnel Project would have the effect of removing I-93 from view. The only adverse effect on these nearby resources would be the potential for construction period impacts such as vibration, which will be mitigated under the terms of the MOA and do not constitute a 4(f) use.

Since the FEIS/R, there have also been changes in the status of historic resources reflected in an updated and expanded historic resources inventory prepared in coordination with the parties to the MOA. These changes are discussed in Chapter 10 of Part I of this SEIS/R. Due to survey programs conducted since 1982 by the Boston Landmarks Commission (BLC), the Department, and others, the historic resources inventory has been updated and is now more detailed, particularly in identifying contributing structures to already known historic

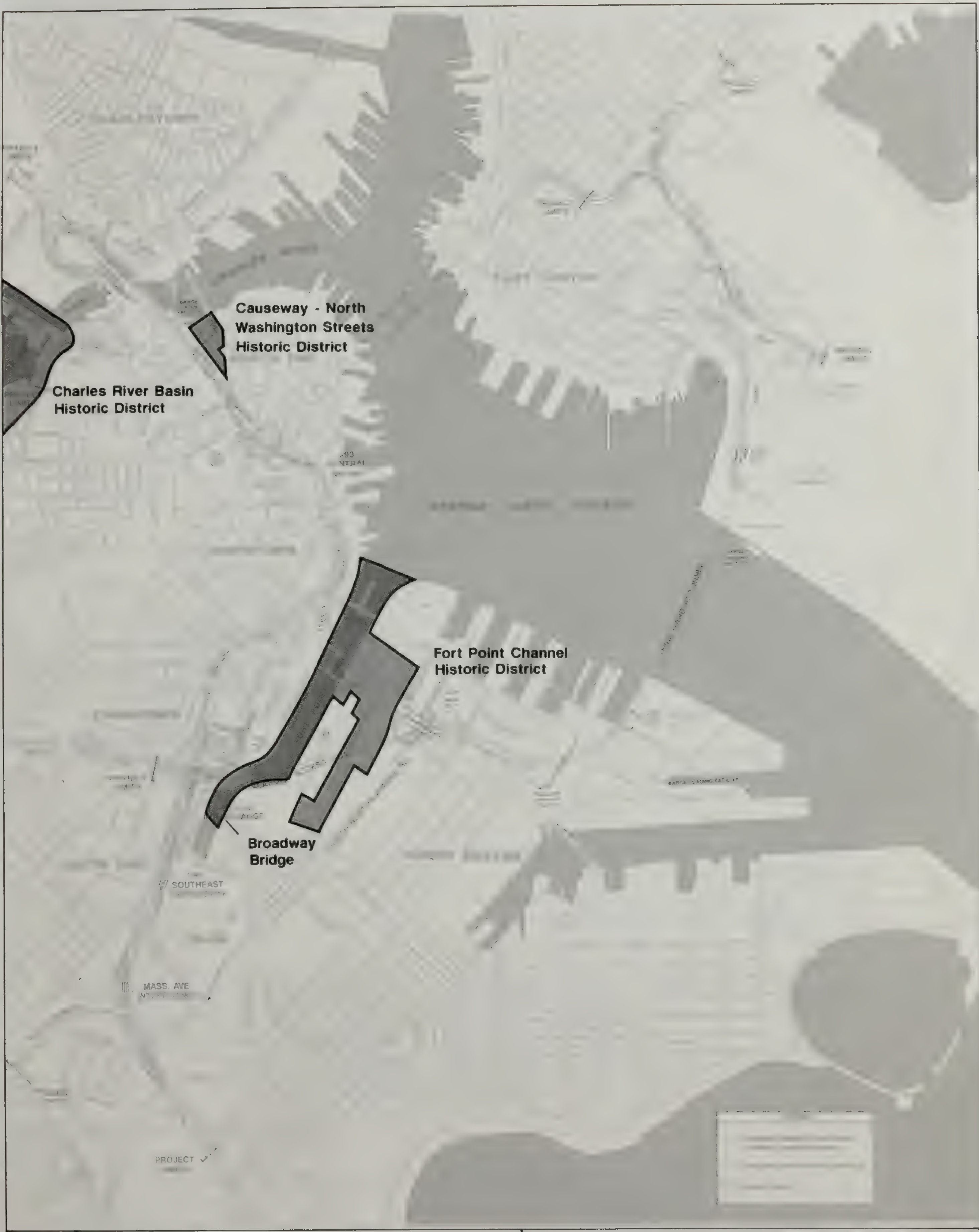

Causeway - North Washington Streets Historic District
Charles River Basin Historic District
I-93 CENTRAL
Fort Point Channel Historic District
Broadway Bridge
SOUTHEAST
MASS. AVE
PROJECT

FIGURE 27

Historic Resources Addressed in 4(f) Evaluation

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SUPPLEMENTAL EIS/R

0 800 1600 2400 3200 Feet

districts (see Historic Appendix). This Section 4(f) update also reflects the more detailed inventory information now available.

3.1 CHARLES RIVER BASIN HISTORIC DISTRICT

3.1.1 Proposed Action

The Proposed Action incorporates a new eastbound underpass below Leverett Circle, at the northeast corner of the Charles River Basin National Register District adjacent to the existing westbound underpass, with the double-decked connecting ramps to I-93. The new eastbound underpass would be south of the existing underpass away from the Charles River's banks and other MDC park facilities. (Leverett Circle is considered parkland. The segment of the Proposed Action which will affect this historic district is described in detail in Part II of the SEIS/R, Chapter 2, for the Area North of Causeway Street and in Section 2.1.2 of this Section 4(f) Evaluation.) Traffic congestion at Leverett Circle is one of the most serious mobility problems in the metropolitan region. Storrow Drive would be extended 20 feet south and Leverett Circle would be reconfigured from a traffic rotary to a new intersection. A larger landscaped area will result.

3.1.2 Description Of The Section 4(f) Property

The Charles River Basin National Register District incorporates the Charles River and the parkways and landscaped areas on both banks for approximately 6 miles upstream from the old Charles River dam (carrying the O'Brien Highway) to the Eliot bridge in Cambridge. It is owned and maintained by the MDC. The elements of the district which are within or adjacent to the project area include Storrow Drive, Leverett Circle, the old Charles River dam, the Police Headquarters and lock houses, the Museum of Science and Hayden Planetarium, and the Street Railway Viaduct.

3.1.3 Impacts On The Section 4(f) Property

Reconfiguration of the northeast terminus of Storrow Drive (Embankment Road) at Leverett Circle and the construction of an eastbound traffic tunnel connecting to existing I-93 ramps will permanently move the south curb line of Charles Street 20 feet south, resulting in a wider roadway. Construction of the eastbound tunnel will have a positive effect on this corner of the district by alleviating the present traffic problems and improving the ambience of the area. In addition, the reconfiguration will remove the traffic rotary at Leverett Circle, and create a larger landscaped area, but will not affect the historic Street Railway Viaduct over Leverett Circle. The Proposed Action has thus been determined to have no adverse effect on the district. The FEIS/R Preferred Alternative also had no adverse effect. Schemes 5A Modified and T Modified both would have some adverse impact on the Esplanade to accommodate construction detours. Schemes S Modified and Z Modified in the Area North of Causeway Street avoids adverse impacts.

3.1.4 Avoidance Alternatives

The Proposed Action avoids 4(f) impacts on the historic district.

3.1.5 Measures To Minimize Harm

The Proposed Action will not take or permanently use any significant historic components of the Charles River Basin Historic District. (See Section 2.1.8 for a description of parkland mitigation.)

3.2 CAUSEWAY/NORTH WASHINGTON STREETS HISTORIC DISTRICT

3.2.1 Proposed Action

The Proposed Action places all of the north- and southbound movements to Leverett Circle from I-93 on the north side of the Charles River in Charlestown (see Section 2.1.4). It includes a modification from a split bridge to a parallel bridge configuration crossing the Charles River; it eliminates a southbound I-93 off-ramp at Causeway Street; and a northbound on-ramp begins at Traverse Street and passes under Causeway Street.

3.2.2 Description Of The Section 4(f) Property

The Causeway/North Washington Streets Historic District is considered eligible for listing on the National Register of Historic Places by concurrence of FHWA and the State Historic Preservation Officer's (SHPO) office. The district comprises late 19th and early 20th-century five- to seven-story brick buildings with notable brick, stone, and metal detailing between the elevated Central Artery and North Washington Street. The district is the eastern half of the original Bulfinch Triangle laid out by Charles Bulfinch in 1808. The western half of the Triangle is west of the Central Artery viaduct and is listed on the National Register of Historic Places as the Bulfinch Triangle National Register District.

The buildings comprising the Causeway/North Washington Streets District were constructed for a variety of mercantile and manufacturing purposes. These include the Charles River Building (1907 and 1909), the attached Hoffman Building (1908 to 1912), the Stop & Shop Bakery Building (1906), the Medford Building (1883 to 1890), the Braman Dow & Company Building (1913), the Standard Shade & Company Building (1898 to 1902), and the Keany Square Building (1906). None of these buildings is individually eligible for the National Register, but together they contribute to the character of this district.

3.2.3 Impacts On The Section 4(f) Property

The Proposed Action avoids the negative impacts of the FEIS/R Preferred Alternative, which would have required taking of 100 feet of the Charles River Building and the Stop and Shop Building loading dock, and would have introduced a ventilation building. Local on- and off-ramps at Causeway Street would conflict with access to these buildings. Scheme Z Modified would have the positive effect of removing the Central Artery viaduct which separates the two historic portions of the Bulfinch Triangle. In addition, in Scheme Z Modified, the design of the northbound I-93 ramp beginning at Traverse Street and passing under Causeway Street would remove traffic congestion from that area. Z Modified avoids any taking of the contributing Stop & Shop and Charles River Buildings, and has no ventilation building or Causeway Street ramps. Avoidance of impacts to these buildings is made possible by the substitution of a Traverse Street on-ramp for ramps at Causeway Street, and elimination of tunnel connections in the Area North of Causeway Street (see Figures 2 and 8). These undesirable features of scheme 5A Modified have been eliminated completely. Scheme Z Modified is the only design option that will allow the removal of the high speed highway ramps from the district. The only adverse effect is due to construction period impacts such as vibration which will be mitigated throughout the project area under the terms of the MOA.

3.2.4 Avoidance Alternatives

The Proposed Action effectively avoids 4(f) use of the district. The 1985 Preferred Alternative required the taking of 100 feet of the Charles River Building and the loading dock at the west end of the Stop & Shop Bakery Building for the construction of the split bridge crossing the Charles River. All schemes studied with split bridge designs involve these takings. These impacts to the Stop & Shop Bakery Building and the Charles River Building would be considered a permanent alteration to the historic fabric and character of the area. Schemes S Modified and T Modified avoid the takings but involve tunnel construction immediately next to both buildings and vehicular conflicts with the Stop & Shop loading dock, and the same Causeway Street ramp impacts as the 1985 (5A Modified) Scheme. Only the Proposed Action, Scheme Z Modified, avoids all of these impacts.

All design options considered for the Area North of Causeway Street would have the positive impact of removing the Central Artery viaduct from the historic Bulfinch Triangle area and of potentially reuniting the Causeway/North Washington Streets District with the Bulfinch Triangle District to the west. The 1985 Preferred Alternative, S Modified, and T Modified would have had other long-term indirect impacts such as substantially increased pedestrian-vehicle conflicts in the area due to proposed Surface Artery and Central Artery ramps. This indirect impact of these options would partially isolate the district, thereby reducing its economic viability and increasing the potential for loss of its other historic buildings.

Scheme 5A Modified located the Leverett Circle/I-93 connector ramps in tunnels behind North Station. A ventilation structure was proposed to be located at the site of the Charles River Building, a significantly adverse effect to the Causeway/North Washington Streets District which is avoided by the Proposed Action. Only Scheme Z Modified avoids these negative impacts.

3.2.5 Measures To Minimize Harm

Construction period vibration and other impacts will be mitigated as provided in the MOA. As described in Section 2.1.8, the provision of a new small park at Causeway Street and the addition of ferry facilities and pedestrian access at a reconstructed Lovejoy Wharf both provide opportunities to enhance these long neglected historic structures.

3.3 FORT POINT CHANNEL HISTORIC DISTRICT

3.3.1 Proposed Action

Refinements to the FEIS/R design would reduce the direct effects of the project in the Fort Point Channel Historic District. The major change is the proposed relocation of the northbound I-93 tunnel from Fort Point Channel to Atlantic Avenue. This design and its potential impacts to historic resources will be discussed first, followed by an outline of changes to the Seaport Access Road at the I-93/I-90 Interchange.

Northbound I-93 Tunnel. The Proposed Action, termed the Atlantic Avenue alignment in this area, will leave the southbound mainline near the West Fourth Street bridge and proceed in the Channel west of the Cabot Yard and through the I-93/I-90 Interchange. The Proposed Action will not entail major filling of the Channel south of Dorchester Avenue. Between Kneeland Street and Northern Avenue, the highway tunnel will be under Atlantic Avenue. (A detailed description of the Proposed Action is contained in Chapter 2 of the SEIS/R, Part I.)

Seaport Access Road. As a part of the Proposed Action, the Seaport Access Road (I-90) will begin at the terminus of existing I-90 at I-93, cross under Fort Point Channel, and travel northeast through South Boston (and the Fort Point Channel Historic District) connecting with the Third Harbor Tunnel at the Subaru Pier. In general, the refinements to the I-93/I-90 Interchange will result in the continuation of the north- and southbound frontage roads and modifications to ramp designs and connections, which not only will improve traffic movements but also enable the development of a more compact interchange with fewer property takings.

3.3.2 Description Of The Section 4(f) Property

The Fort Point Channel Historic District is located in South Boston and encompasses 98 industrial, commercial, and civic buildings, as well as five bridges which span Fort Point Channel. In 1983, FHWA and the SHPO's office concurred that the district is eligible for listing on the National Register of Historic Places. The district is bounded roughly by the western edge of Fort Point Channel to the west, Northern Avenue to the north, the former track beds of the New York, New Haven and Hartford Railroad to the east, and Richards Street to the south. Most of the land and buildings within the district were developed by the Boston Wharf Company during the 19th century (between 1839 and 1882). The Channel itself was laid out and the first granite seawalls constructed in 1837. It is about 1.25 miles in length and varies in width between 260 and 1,110 feet. When first constructed it was the "Gateway to New England," increasing access to the South Cove area of Boston. Numerous railroad and vehicular bridges have spanned the Channel, of which seven remain. Five of these bridges are either contributing structures to the district or individually eligible for listing on the National Register of Historic Places.

The district is characterized by well preserved late 19th and 20th century masonry buildings which range in height from five to six stories and represent a variety of architectural styles. Most of the buildings within the district were designed by Morton D. Safford, Boston Wharf Company's staff architect from 1893 to 1917, and his successor, Howard B. Prescott (1917 to 1939).

The Fort Point Channel Historic District possesses integrity of location, design, setting, materials, and workmanship. Its historical association with Boston's, and particularly South Boston's, maritime and industrial development, makes it eligible for listing on the National Register of Historic Places because it is associated with events that have made a significant contribution to the broad patterns of our history, it embodies the distinctive characteristics of late 19th century industrial districts, and it is a significant and distinguishable entity whose components may lack individual distinction.

Since 1983, the Department has conducted a Statewide bridge survey and determined that the Broadway bridge, located within the Fort Point Channel district, is individually eligible for listing on the National Register of Historic Places because of its engineering attributes. The SHPO's office has concurred with this determination.

The drawspan of the Broadway bridge is the largest and most impressive of the four surviving center-bearing swing bridges identified in the Department's bridge survey. Although a total of 13 surviving swing bridges (some of them no longer operable) have been identified, the large majority (nine) are the rim-bearing type. Only the Congress Street bridge in Salem (ca. 1916), the Main Street bridge in Amesbury (rebuilt 1966, possibly reusing an 1882 pier and bearing), and the Bass River bridge in Beverly (1929) share the center-bearing configuration with the Broadway bridge.

The Broadway Bridge was built by the Boston Bridge Works, established in Cambridge in 1876, was one of the most prolific New England bridge-building firms of the late 19th and early 20th centuries. To date, over 50 surviving examples of their work have been identified in Massachusetts.

The Massachusetts Historic Bridge Inventory Report indicates that the center portion of the Broadway bridge, specifically the draw span of the center-swing bridge (built 1914) and the center pier stonework (possibly 1874-75), are its most significant historical elements. The historical integrity of the approach spans has been reduced by partial reconstruction over the past 60 years. The end piers and spans and the original timber deck approaches were replaced in 1953. The Bridge Inventory Report indicates that the Broadway bridge's site integrity is violated, primarily by the Southeast Expressway and MBTA railyards, and that it has low visual quality.

3.3.3 Impacts On The Section 4(f) Property

The Proposed Action, Atlantic Avenue alignment, will substantially reduce impacts to the Fort Point Channel Historic District by removing the northbound Central Artery tunnel structure from the Channel, avoiding all use of land in and along the west edge of the Channel and alteration of the bulkhead north of Dorchester Avenue, and eliminating disturbances to the Summer Street and Congress Street bridges.

The Seaport Access Road portion of the Proposed Action continues to require replacement of the Old Colony Railroad Bridge (1896-98) (also known as the New York, New Haven and Hartford Railroad Bridge). In addition, construction of the Seaport Access Road tunnel (and graving basin for tunnel section assembly) will continue to require the removal of approximately 400 feet of the east and 400 feet of the west portions of the historic Fort Point Channel bulkhead.

The Proposed Action continues to include a ventilation structure for the Seaport Access Road (ventilation building 1) located just west of the Dorchester Avenue bridge. Portions of this building will be within the current boundary of the Fort Point Channel District (defined by the Old Colony Railroad Bridge and the Channel bulkhead) and on land which would be made by filling the area between the Dorchester Avenue bridge and the Old Colony Railroad Bridge. This new bulkhead line will be granite-faced. The Proposed Action alignment will continue northeast through South Boston, crossing the Fort Point Channel District. The

Proposed Action would cross the district in tunnel and would be hidden from view, except for its ventilation structures, which are similar in scale and character to the industrial buildings comprised by the district. As in the 1985 Preferred Alternative, two contributing structures which are not individually eligible would be taken.

The Broadway bridge's draw span and its supporting center pier stonework (1874-75) are the most significant historic elements of the center-swing bridge. These historic features are not expected to be directly affected by the construction or operation of the project; however, serious structural problems threaten the viability of the bridge, independent of the project.

Construction of the new northbound Frontage Road will require an at-grade intersection with the bridge between piers 16 and 17, thereby altering the appearance of the western approach span.

Relocation of the railroad Wye Connector under the Broadway bridge also will require structural modification of the bridge at this point for vertical clearance, and potentially require the replacement of one bridge pier for lateral clearance.

3.3.4 Avoidance Alternatives

As discussed in the FEIS/R, it is not possible to avoid the district entirely because of its proximity to the I-93/I-90 Interchange. No alternative which provides a cross-harbor tunnel connection can entirely avoid the southern end of the district and the Old Colony Railroad Bridge which lie immediately east of the terminus of the Massachusetts Turnpike (I-90).

The Proposed Action minimizes harm but does not completely avoid the district. Since the FEIS/R, additional tunnel engineering effort was applied to the problem of an alternative location for the northbound lanes of the Central Artery. A solution was developed for an Atlantic Avenue alignment which was not previously believed to be feasible because of conflicts with the South Station Red Line rapid transit station and the East Side interceptor sewer. By utilizing a recently developed jacked-pipe tunneling technology, it was found to be possible to construct the highway tunnel under the Red Line tunnel rather than over it as in the FEIS/R study of this alternative alignment; the new lower profile tunnel avoids conflicts with the Red Line mezzanine and no longer requires moving the interceptor sewer out of Atlantic Avenue.

The other alternatives considered in this area are the 1985 Preferred Alternative and the more recent Dorchester Avenue concept, both of which have substantially greater impacts on the district. Both would require removal of 2,200 linear feet of the west Fort Point Channel bulkhead, removal of 400 linear feet of the east bulkhead, demolition of the Old Colony Railroad Bridge, and alteration of spans of the Summer Street bridge. A ventilation structure would be located in the filled portion of Upper Fort Point Channel south of the Dorchester Avenue bridge.

The 1985 FEIS/R design and all other alternatives studied since would have required demolition of the Broadway bridge and construction of a new bridge.

3.3.5 Measures To Minimize Harm

The Section 106 Memorandum of Agreement signed in 1984 stipulated the following measures to mitigate the effects to the Fort Point Channel Historic District:

- Design and location of the ventilation building will be done in a manner that is sympathetic to, and respectful of, the characteristics of surrounding historic properties with regard to massing, color, building material, detail, and scale.

- Granite facing will be used in the new sections of the Fort Point Channel bulkhead to make it visually consistent with the existing bulkhead in color, texture, configuration, and design.

- Reconstruction of the one span of the Summer Street bridge removed during project construction will be in a manner that reuses as much of the original fabric as possible and results in the same configuration as the original.

- Landscaping improvements along the Boston side of the Channel will be designed to enhance those characteristics of the historic district that make it eligible for listing in the National Register of Historic Places.

- During preliminary project design, there will be continuing study and negotiation with the U.S. Postal Service concerning the use of land between the existing Dorchester Avenue and the Channel bulkhead for project right-of-way. The final design of the new Dorchester Avenue will be such as to minimize impacts to the historic characteristics of Fort Point Channel and adjacent historic resources, including impacts related to pedestrian and vehicular traffic flow.

- Preliminary and final design, and construction specifications, will be submitted to the SHPO, prior to start of construction, for review and approval in consultation with the BLC regarding consistency with the design development guidelines outlined above.

- Historic American Engineering Record (HAER) documentation of Fort Point Channel and the Old Colony Railroad Bridge will be supplied.

Reconstruction of the Summer Street bridge (#3) is no longer necessary, as the Proposed Action will not affect the bridge. The Proposed Action does not require the use of the Channel or its bulkhead for a new Dorchester Avenue (#5). All other stipulations will be incorporated into Final Section Design packages or, in the case of documentation, carried out by qualified historic resources consultants. The level of documentation required for the Old Colony Railroad Bridge has been determined which will be implemented.

Although the Broadway bridge may not be viable for reasons not connected with the project, the project would have sufficient adverse effect on some spans to warrant HAER documentation of the bridge; this documentation will be provided in coordination with the Project Conservator.

4 ARCHAEOLOGICAL RESOURCES

This section is an update of the archaeological resource section of the 1985 Section 4(f) Evaluation. In summary, no site affected by the Artery/Tunnel Project meets the criteria for preservation in place, and therefore there is no 4(f) use of archaeological sites. (See Chapter 11 of Part I of this SEIS/R.)

The Artery/Tunnel Project has conducted an archaeological survey of the Proposed Action to identify sites considered eligible for listing on the National Register of Historic Places. Phase I of the survey completed a background research study of historical documents and maps, utilities information, building demolition, and details for the construction of the Central Artery, existing conditions, geotechnical and environmental soil conditions, and existing archaeological site information. A research design delineating project significance criteria addressed research questions at the local, regional, and national levels.

As a result of the Phase I survey, six potentially significant areas were archaeologically tested in Phase II. The Phase II program was reviewed and approved by the SHPO's office and BLC, and a State permit for archaeological testing was issued.

The Phase II program located three archaeological sites which are recommended as eligible for listing in the National Register of Historic Places and a fourth eligible site is located on Spectacle Island. All other areas studied and tested were either disturbed by 20th century construction, particularly of the Central Artery viaduct, lacked sufficient integrity of location and features to meet National Register criteria of significance, or did not meet the criteria of significance relative to the project research design.

Three archaeological sites are located between Cross and Blackstone Streets in the North End. They are known as Mill Pond Wharf, Cross Street Backlot, and Paddy's Alley.

The Mill Pond Wharf site is located between Hanover and North Streets and contains remains of an early 18th century wharf, and intact deposits dating to the Early Republic period, including Mill Pond fill episodes. This site is considered eligible for listing on the National Register under criterion D, in that it may yield information important to history or prehistory, but does not warrant preservation in place. It is significant as a unique survival of a little-known aspect of Boston's early history -- a private wharf, evidence of waterfront activity, building, and probably commerce along the shore of original land and the Mill Pond. Excavation of this site could provide information about a variety of questions concerning use and adaptations along the original shoreline of the Shawmut Peninsula; commercial and possibly recreational facilities, privately owned, on a part of Boston's waterfront other than the main Harbor; the form and construction technology of early, small-scale wharves; and the relationship between wharf and original shoreline. The site also has the potential to provide information through pollen profiles of the soils of prehistoric environmental conditions.

The second and third archaeological sites are the Cross Street Backlot site and the Paddy's Alley site. Neither of these sites warrants preservation in place. Their significance lies in the information and articles which can be retrieved and studied.

Archaeological components from the two ca. 1680-1740 house or "back" lots included a refuse pit, a post mold, and a stone wall; and intact stratified deposits contained abundant artifactual and organic assemblages which reflect a series of domestic occupations. An early 19th century privy type feature also was discovered. These resources are significant under criterion D, may be likely to yield information important to Boston's settlement history. These backlots are representative of the intensification of residential development during the early 18th century in the North End, as the original 17th century lots were being split up into increasingly smaller lots. Only one other backlot of this period has been discovered and excavated in Boston Proper: the Wilkenson Backlot site in the adjacent Blackstone Block Historic District.

Spectacle Island also is listed in the National Register of Historic Places as a part of the Boston Harbor Islands Archaeological District for its known and potential prehistoric archaeological resources. One prehistoric site (19-SU-38) has been confirmed in a survey performed by the Office of Public Archaeology at Boston University in 1987. Documentary research has also indicated that numerous historical activities have occurred on the island since the 17th century. There are no existing significant historic resources on Spectacle Island. A Phase III archaeological data recovery operation is recommended. This site meets Criterion D for listing on the National Register but does not warrant preservation in place. As such, it is not subject to Section 4(f).

In conclusion, although the three sites described above may yield information, no site affected by the Project is considered a 4(f) Resource.

5 COORDINATION

The Proposed Action and drafts of this Section 4(f) Evaluation are subject to review and comment by the following agencies having jurisdiction for protected resources: the MDC, which owns Paul Revere Landing Park and Charles River Reservation and plans to acquire other riverside lands along the Lower Charles River; the City of Boston, which owns East Boston Memorial Stadium Park, and part of Spectacle Island, as well as other parks not affected; the Massachusetts Department of Environmental Management which oversees Boston Harbor Islands State Park and owns part of Spectacle Island; and Massachusetts Historical Commission for 4(f) properties.

In addition, the following agencies have been regularly consulted: Cambridge Historical Commission; Boston Landmarks Commission; the MBTA, which owns the commuter railroad trestle upon which pedestrian walkways have been built and the Science Park MBTA station structure over Leverett Circle; the DEP because of its Chapter 91 Waterways License, water pollution control, solid waste removal, and air and noise control requirements; and other pertinent agencies including those concerned with fisheries in the Charles River.

Coordination and consultation meetings since the FEIS/R to date are as follows:

Coordination meetings with the Massachusetts Historical Commission were held on the following dates:

January 16, 1987
September 1, 1987

June 16, 1988
August 11, 1988
September 15, 1988
July 20, 1989
August 10, 1989

A latest consultation with MHC was held on March 7, 1990, at which concurrence was reached on historic and archeological resources.

Coordination meetings with the Metropolitan District Commission were held regarding parkland and open space impacts and mitigation in the Area North of Causeway Street on the following dates:

July 2, 1987
September 30, 1987
November 9, 1987
June 15, 1988
November 22, 1988
December 8, 1988
September 25, 1989
November 20, 1989
December 7, 1989 (with other agencies)
January 23, 1990
February 13, 1990
April 4, 1990

Coordination meetings with the City of Boston occurred on the following dates:

March 2, 1988 (East Boston Memorial Stadium)
March 9, 1988 (East Boston Memorial Stadium)
May 19, 1988 (Spectacle Island)
February 8, 1989 (Spectacle Island - with DEM)
April 6, 1990 (East Boston Memorial Stadium)

Coordination meetings with the Massachusetts Department of Environmental Management regarding Spectacle Island occurred on the following dates:

August 4, 1988
October 3, 1988
January 13, 1989
February 8, 1989 (with the City of Boston)
October 10, 1989

The Department recognizes the need for continuing coordination with and advice from the agencies listed above in subsequent stages of the environmental review and design development processes.